PEOPLE AND PLANTS IN NORTHERN PERU:

AN ETHNOARCHAEOLOGICAL STUDY OF THE USE OF PLANTS IN

THE FISHING COMMUNITY OF HUANCHACO

A Dissertation

by

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ABSTRACT

Ethnoarchaeology studies modern patterns of human behavior to understand and reconstruct past cultural practices as reflected in the archaeological record. The well-studied flora, the good preservation of botanical remains, and the well-known cultural groups, make the northern coastal region of Peru an ideal study area to conduct ethnoarchaeological investigations on plant uses. Huanchaco is a beachside town located in northern Peru where the local fishing community relies on traditional ecological knowledge (TEK) about the use of plants. TEK is observed in the construction of reed vessels, known as *caballitos de torora*, that they use daily for fishing. TEK has been transmitted since prehispanic times as evidenced in the archeological record. To understand the role of plants in the development of human subsistence strategies through time, this dissertation identifies past and present relationships between the fishing community and useful plants of Huanchaco. Modern botanical specimens were collected and identified, today's fishermen and their relatives were interviewed about the modern plant uses, and plant remains from Initial Period (1500 – 1200 BCE) occupations were analyzed. Results show that the fishing community of Huanchaco use plants mainly for food, medicinal and industrial purposes. Plants from the Fabaceae, Asteraceae and Cucurbitaceae are the most predominant in the modern record and taxa from Poaceae, Solanaceae, Amaranthaceae, Asteraceae and Fabaceae in the archaeological record. Ethnoarchaeological studies along with historical and prehispanic evidence suggests that TEK on plant uses adapted through the generations in response to economic and technological changes that accompanied globalization processes. TEK on the use of plants still plays an important role in the everyday practice of strategies for subsistence in the fishing community of Huanchaco and is considered part of the Peruvian cultural heritage.

DEDICATION

To the human that has always believed in me. Mom, this is for you.

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The research in chapter II was completed by the student, in collaboration with Allison L. Hopkins of the Department of Anthropology at Texas A&M University and Fiorella Villanueva of the Magdalena Pavlich Herbarium at Universidad Peruana Cayetano Heredia Lima, Peru

The case study on totora use presented in chapter IV was conducted in part by Allison L. Hopkins of the Department of Anthropology and was published in 2018.

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CHAPTER I

INTRODUCTION

I.1 Overview

Peru is a megadiverse country where botanical resources have played an important role in the development of human subsistence strategies through time. The use of plants in prehispanic occupations along the coast contributed to the development of social complexity in later cultures as observed in the archaeological record (Quilter and Stocker 1983; Sandweiss 2009). Despite the influence of globalization processes, some Peruvian cultures still rely today on Traditional Ecological Knowledge (TEK) on the use of plants for subsistence. As observed in northern Peru, some cultural groups continue using TEK in everyday life, including the use of plants in economic and social practices. The well-studied flora, the good preservation of botanical remains, and the well-known cultural groups, make the Peruvian north coast an ideal area to conduct ethnoarchaeological investigations with a focus on plant uses. However, flora-related studies are scarce as coastal communities are mainly studied with a focus on the relationships that people have with the ocean, emphasizing their fishing activities. Prior archaeological research (Hastings 1973; Pozorski and Pozorski 1979; Briceño and Billman 2008) relied exclusively on non-botanical evidence, such as ceramics and marine remains, to address questions about social dynamics and economic interactions of past coastal peoples. In addition, most of the ethnographic work in Peru is conducted in the Amazonian and Andean regions where local peoples are relatively less influenced by the industrial revolution (Balslev et al. 2010; Paniagua-Zambrana et al. 2017; Pirker et al. 2012; Sumida 2016).

Huanchaco is a coastal town in northern Peru where the local fishing community uses TEK related to the use of plants that grow in different nearby habitats for subsistence. An Initial Period (1500-1200 BCE) site, known as Gramalote, in the Huanchaco area has been studied with a focus on reconstructing the social and economic activities within the fishing settlement. The archaeological evidence suggests that the ancient fishing village of Gramalote had access to organic and inorganic resources, including botanical resources (Prieto 2015). To understand the role of plants in the development of human subsistence strategies over time in the fishing community of Huanchaco, the objective of the present ethnoarchaeological research was to identify past and present relationships between members of fishing community and the local useful plants. To achieve this, I tested the central hypothesis that the fishing community of Huanchaco has been using plants since prehispanic times and that their TEK on plant uses has been transmitted and preserved across generations. Botanical specimens from the modern vegetation were identified, fishermen and their wives were interviewed to gather diverse information about their use of plants and botanical remains from the Gramalote site were analyzed. Results of this research is pioneering in that it emphasizes the cultural and economic importance of botanical resources in Peruvian human development and cultural heritage.

I.2 Background

I.2.1 Traditional Ecological Knowledge (TEK) on plant uses

As defined by Berkes and colleagues (2000), traditional ecological knowledge (TEK) refers to the knowledge, practices, and beliefs of the relationships between living beings and their environment. Studies on TEK in diverse cultural and geographic settings explain the social mechanisms related to acquisition and transmission of knowledge that increases the capacity of human systems to adapt and cope with change (Athayde et al. 2017; Reyes-García et al. 2014). Some of these social mechanisms have decreased whereas others have been maintained and/or adapted, promoting resilience to change and the continuity of cultural traditions (Carpenter and Brock 2008). However, that resilience is undermined by factors that include modernization, technology and integration into the market economy. These factors affect the strategies that communities use to generate, regenerate, transmit and apply TEK (Gómez-Baggethun and Reyes-García 2013).

TEK's dynamic response to change is observed in the persistence and change of the use of plants in a cultural group over time. For example, people can adapt TEK in basketry weaving by replacing raw materials to cope with environmental changes that affect plant abundance (Athayde et al. 2006), developing basketry designs by copying photographs, drawings or book illustrations brought by globalization processes (Athayde et al. 2017), and complementing knowledge of medicinal plants with knowledge of pharmaceuticals in response to industrial change (Giovannini et al. 2011). The study of TEK on plant uses, ethnobotany, not only provides a list of botanical species and their uses, it also explains how humans are able to adapt their plant knowledge for subsistence. The local observational knowledge of botanical species in relation to the environment, the way people carry out plant use activities, and the belief regarding how people fit into ecosystems are three components of TEK that help researchers understand people-plant relationships (Berkes 1999). Chapter II, an ethnobotanical study where modern plant uses are studied under the premise of the TEK components, emphasizes the dynamic quality of TEK on the use of plants for subsistence in the fishing community of Huanchaco.

I.2.2 Botanical remains for the study of ancient subsistence

The study of archaeological botanical remains and human-plant interactions in the past, known as paleoethnobotany, addresses diverse research questions that include site formation processes (Pearsall 1988), paleoenvironmental reconstructions (Smart and Hoffman 1988), agricultural practices (Hastorf 1988), culture change (Johannessen 1988) and diet reconstructions (Pearsall 2000). Macro and microbotanical remains are collected from archaeological contexts, processed and identified to understand human culture in relation to plant uses. Macrobotanical remains including seeds, flowers, and stems are identified by naked-eye; whereas microbotanical remains such as pollen, starch and phytoliths are identified using a microscope. These remains provide insights to when, where and how people used plants to reconstruct ancient subsistence economies as well as the degree to which people relied upon domesticated plants (Smith 2001). Paleoethnobotanical research emphasizes the importance of the study of past human-plant interactions for understanding the present as it provides rich sources of information on human adaptation to economic, social, geographic and climatic transitions over long spans of time. This information is directly relevant to assess the sustainability of similar subsistence systems in the present (Marston et al. 2014). For this reason, a paleoethnobotanical research was included in chapter III of this dissertation where macro and microbotanical remains were analyzed from sediment samples of the Gramalote site to reconstruct the past relationships between the ancient fishing community of Huanchaco and the plants that grew in that territory.

I.2.3 Ethnoarchaeological approach

Ethnoarchaeology embodies a range of methodologies to study the relationships of material culture to culture in living and archaeological contexts (David and Kramer 2011). Ethnographic data is used to inform and interpret the past record as patterns that reflect consistencies in human behaviors which may be predictable under recognized conditions (Gould 1978). Although sociocultural mechanisms change over time, ethnoarchaeologists have identified, under the principle of uniformitarianism, shared patterns in production, use, trade and abandonment of material culture in diverse groups of people, in different environments and habitats, and at different levels of technology (Coon 1958; Steward 1955; White 1959). In these terms, TEK of modern cultural groups may have originated in ancient times with subsistence practices being preserved across generations. For this reason, I present an ethnoarchaeological study to understand the role of botanical resources in human subsistence over time in the fishing community of Huanchaco. Plant use categories identified in the modern plant record reported in chapter II were used to interpret, through ethnographic analogy, the past plant record in chapter III. Historical evidence from the colonial period, in addition to paleoethnobotanical and ethnobotanical evidence are analyzed in chapter IV for the study of plant uses across time. This ethnoarchaeological research is proposing a new approach on the study of plants that may be considered in the conduction of multidisciplinary anthropological projects in coastal Peru.

I.3 Research Objectives

The primary objective of this ethnoarchaeological research was to identify the relationships between the fishing community and the botanical resources in Huanchaco to understand the role of plants by identifying persistence and change of TEK in the subsistence practices that people have performed since prehispanic times. The specific aims of this ethnoarchaeological study, which constitutes this dissertation, were to: 1) investigate the modern uses of plants by identifying plants in the habitats of Huanchaco that are being collected and processed today by members of the fishing community, 2) reconstruct the paleoethnobotanical record by analyzing macro and microbotanical remains, and 3) combine the data provided by the modern plant TEK and the paleoethnobotanical record to further understand the relationships between people and plants over time in Huanchaco.

Three independent projects (chapters II, III and IV) were conducted to address the ethnoarchaeological approach of this dissertation. The first project, chapter II, focused on the ethnobotany of Huanchaco and will be submitted to the *Journal of Ethnobiology* for publication. The article, co-authored by Allison L. Hopkins and Fiorella Villanueva, reports the modern uses of plants in Huanchaco, including TEK on cultivation, collection, processing and preparation of plants differentiated by gender and age attributes. The second project, chapter III, constituted the reconstruction of the paleoethnobotanical record of the Gramalote site and was published in the journal *Economic Botany*. The analysis of pollen grains and macrobotanical remains reveals that ancient coastal communities in northern Peru relied on the use of plants more than previously believed, which suggests that botanical resources were fundamental for subsistence. The third project, a case study presented in chapter IV, was published in the journal *Ethnobiology Letters*. The article, co-authored by Allison L. Hopkins, emphasizes the adaptive capacity of TEK to social change in the use of totora (*Schoenoplectus californicus*) by members of the fishing community of Huanchaco.

Chapter IV presents an ethnoarchaeological interpretation of the use of plants in the fishing community through time using the findings from the previous chapters and historical evidence. The analysis of archaeological and ethnographic evidence demonstrated persistence and change in TEK on plant uses across time. Some plants are still used for the same purposes as in the past but other plants were replaced by commercial products of the technological innovation. Chapter V concludes this dissertation by highlighting the important role of botanical resources in the development of human subsistence strategies since ancient times in the fishing community of Huanchaco and emphasizing the cultural and economic value of plants as part of the Peruvian cultural heritage.

I. 4 Study Region Description

I.4.1 Archaeological Overview of the Ancient North Coast of Peru

Specialized maritime residential settlements along the coast of Peru were situated in environments where littoral, arid plains, and hilly habitats influenced a sustained marine foraging tradition throughout the late Pleistocene and Holocene (Dillehay 2011).

During the early-middle Holocene boundary (6250 BCE), people along the coast intensified fishing and marine mammal hunting. Such aquatic resources were the economic basis for the first sedentary and complex communities (Dillehay 2011). During the middle-late Holocene boundary (2250 BCE), population density increased and resource exploitation intensified as evidenced in the study of diverse sites dating 3500 years ago. Throughout the Late Preceramic (3000–1800 BCE) the first large coastal temples appeared and animal remains were predominately marine (Moseley 1975). Agriculture was also an important subsistence development that promoted sedentarism (Bird 1948). Shady's work at Caral (Shady 2009), which dates 2600–1800 BCE, revealed a sizeable agricultural community that produced a variety of cultigens including beans, squash, sweet potato, avocado, and especially cotton. Caral has seven large mounds, sometimes associated with sunken circular and rectangular plazas (Shady 2009).

The Initial Period (1800–900 BCE) was marked by the appearance of ceramics. In addition, true weaving replaced twining for textile manufacturing and recovered cultigens documented more sophisticated agricultural practices such as irrigation (Lanning 1967). The quantity of consumed plants appears to have increased as seen in the broader consumption of maize. Most of the largest and U-shaped mound sites were located inland at optimum locations for canal intakes. The Early Horizon (900–200 BCE) highlighted the spread of the Chavin culture, notable for its monumental architecture, finely carved stone sculpture, and elaborate iconography (Burger 1984). The Moche developed as independent and interacting polities in the northern valleys of coastal Peru during the Early Intermediate (200–700 CE). Moche people combined maritime resources with an advanced agriculture based on irrigation technology. The Moche pottery is realistic and rich in images of deities interacting in myth and ritual as well as humans performing all sorts of religious and mundane activities. Ceremonialism and the development of more refined ritual objects and paraphernalia all materialize an ideology that emphasized social division and status differentiation (Quilter 2014). During the Middle Horizon (700–1000 CE) the Tiwanaku and Wari civilizations emerged with cities, state governments and imperial systems, with populations exceeding 15,000 inhabitants from the central Andes to the Peruvian north coast. Both civilizations shared religion represented in their SAIS (Southern Andean Iconography Series) iconography but were different in their construction of place. Tiawanaku was more ceremonial whereas Wari was more administrative and residential (Isbell 2008). Between the periods of the Wari civilization and the Inca empire (1000-1400 CE), complex polities emerged such as the Chimu Empire. The Chimu managed to expand and maintain large multi-valley systems of artificial irrigation, build impressive public monumental architectural complexes, control far-reaching and complex trade networks, and produce large amounts of fine manufactured goods along the southern part of the north coast (Moore and Mackey 2008).

I.4.2 Huanchaco

This study took place in Huanchaco, a beachside town with a population of 68,104 (INEI 2018) located in the La Libertad region of northern Peru (Figure 1). The coast of Peru is a sandy strip that lies between the Pacific Ocean and the Andes mountains. In places, the coastal desert is crossed by rivers flowing from the highlands that provide irrigation to crops cultivated in the local river valleys and slash the sands with patches of green (Benson 2012). Around Huanchaco, both wild and cultivated botanical resources grow in habitats between the shoreline and inland territories (McTavish 2013). Agricultural fields are observed in Huanchaquito, a neighborhood of Huanchaco, where a limited number of fruits and vegetables are cultivated in small areas for commercial purposes or personal consumption (Figure 2a). Green spots of wild plant specimens grow within the disturbed areas of the agricultural fields (Figure 2b). In addition, totora (*Schoenoplectus californicus*) reeds grow in sunken gardens, locally known as *wachaques*, located 4 km north of Huanchaco in a protected reserve (Figure 2c). The artificially constructed sunken beds are located close to the shoreline where the high-water table provides an appropriate growing condition for the aquatic sedge. Extended families, members of the local fishing community, own portions of that land where they cultivate and harvest totora reeds using a traditional process (see Banack et al. 2004).

The traditional culture of Huanchaco dates back to pre-Hispanic times. During the Initial Period (1500 – 1200 BCE), the fishing community of Gramalote settled in Huanchaquito and exploited marine resources while following a marine-oriented ideology (Prieto 2015). Then, Salinar (200 BCE – 200 CE), Gallinazo (200 BCE – 300 CE), Moche (100 – 700 CE), and Chimu (1000 – 1400 CE) peoples continued to inhabit and use the Huanchaco coastal port for daily embarkations (Anhuamán 2014). The traditional fishing systems and the domestication of plants, together, promoted the rise of political and social complexity in coastal Peru (Sandweiss 2009) and resulted in continuation of Huanchaco fishing activities during the Inca Empire and through the Spanish Conquest in 1572. During colonial times, Huanchaco was an important port through which Spanish people and merchandise entered the region, serving as a catalyst for culture change. Technological innovations were introduced and pre-Hispanic sea vessels within the fishing communities started to be displaced by occidental types (Ortiz 2003).

Today Huanchaco is divided into urban and rural areas. In the urban areas, most jobs are administrative and/or associated with providing public and private services, whereas in the rural areas artisanal fishing and totora cultivation are the most common means of subsistence (Pulido 2010). The main economic activity in Huanchaco is tourism, primarily due to its designation as a World Surfing Reserve in 2013 (Save the Waves 2015). People from around the world visit the town demanding services and facilities that meet international standards. As the tourism industry has grown in the region, it has provided increasing job opportunities that have attracted former fishermen and/or their sons. Also, unsustainable fishing practices such as overfishing and sea contamination (Veneros 2008) have affected fishing performance and catchment and forced some people to look for alternative economic activities to support their families. Additionally, the political system has not always worked in favor of the fishing community. Some of the previous mayors allowed for the expansion of the urban area to meet the tourism demand which reduced the availability of land for the cultivation of crops and totora by fishermen (Pulido 2010). Despite these changes and the reduction in the number of active fishermen as a result, some families continue to fish using traditional reed vessels.

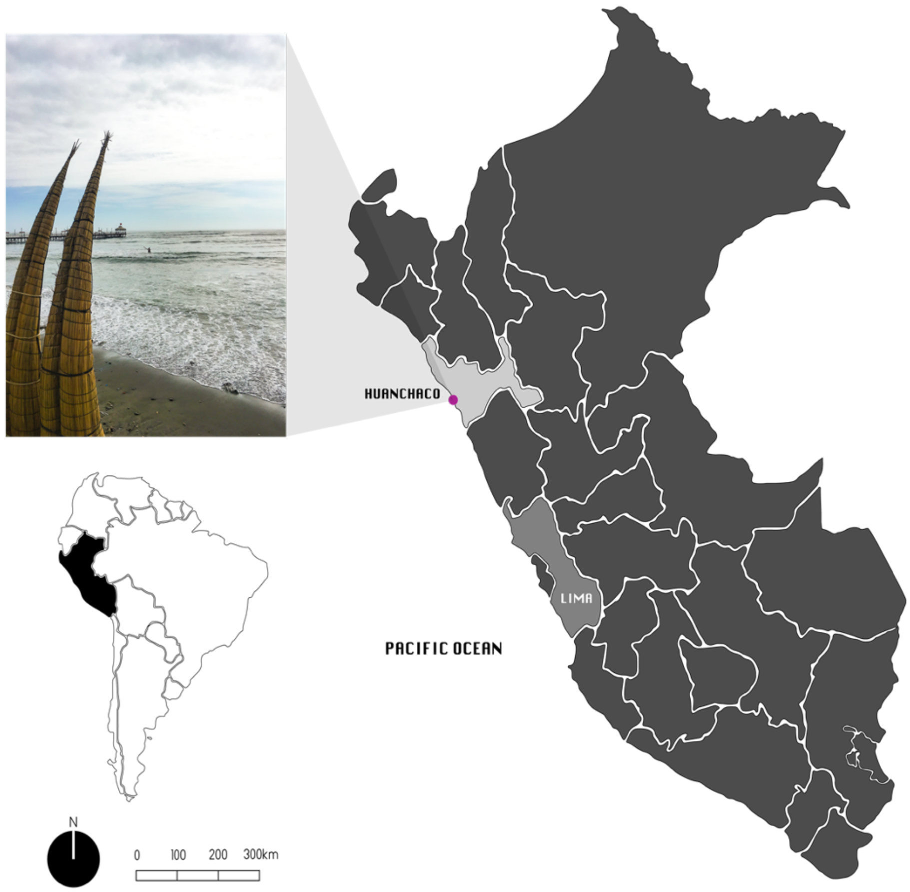

Figure 1 Location of Huanchaco in northern Peru. Reprinted with permission from Paredes and Hopkins 2018.

Figure 2 Habitats observed in Huanchaco. 2a, b: river valleys with agricultural fields and wild flora. 2c: sunken gardens where totora reeds are cultivated.

I.4.3 The Fishing community of Huanchaco

The research work presented in this dissertation was exclusively conducted with the members of the fishing community of Huanchaco, which is defined as a group of 30 men and their families that continue rely on artisanal fishing as their main economic activity. The archaeological evidence was analyzed from samples collected from the Gramalote site where the ancestors of the modern fishing community settled. All the members of the fishing community that participated in this investigation are recognized as part of a local association of fishermen. They meet every month to discuss fishing concerns, develop fishing techniques, organize social events and look for opportunities to improve their economy. As mentioned, the number of fishermen has reduced as a consequence of the influence of modernization and globalization processes. Five years ago, there were 150 members and today there are only 30 members. Most people, especially younger generations, prefer today to work in other economies or travel to bigger towns where they can generate more income. However, the current members are willing to continue preserving their traditions as the construction of reed vessels for fishing, an activity only observed in this town of Peru and that make it unique when compared to other coastal towns.

There is a gender division of labor in the fishing community of Huanchaco. Men oversee all the fishing practices which requires them to spend most of their time away from their homes; whereas women are mostly responsible for the welfare of their families, including the cooking and the care of their children, which requires them to spend most of their time in their homes. TEK is shared while men and women are performing their daily activities. Men share totora TEK during fishing and totora cultivation routines. On the other hand, women share TEK on food and medicinal plants while buying edible products in the local markets or collecting wild plants. In addition, younger people from both genders ask for cooking and traditional medicine recipes to older generations that will benefit their subsistence.

I.4.4 The Gramalote Site

Gramalote is a 2.3 ha archaeological site that lies on top of a 13 m high marine terrace overlooking the beach of Huanchaquito and surrounding marshlands where totora reeds are predominant. Low hills are present on the southwest sector protecting the site from cold winds during the winter season. Twelve kilometers northeast of the site is located Cerro Campana, a mountain with a fog system vegetation where bromeliads (*Tillandsia* sp.) grow during the winter season. Also, a dry river is present along the south-east and northern ends of the site suggesting the probable availability of fresh water in the past, especially during summer seasons (Prieto 2015). People could take advantage of a high-water table during the entire year in the lower lands surrounding the site.

The Gramalote site was discovered during the excavations of the Chan Chan Moche Valley Project in 1973. Since then, archeologists have been studying the architecture (Hastings 1973), layout (Pozorski and Pozorski 1979), and diet composition (Pozorski 1976) of the early settlement. This research concluded that Gramalote was a domestic fishing settlement focused on systematic seafood procurement, trading plant products with inland agriculture systems (Pozorski 1979). Later, Velásquez (1987) started excavations on the east side of the site and identified activity areas related to seafood processing and cotton net elaboration. During the Briceño and Billman excavations in 2005, two human burials and evidence of food consumption were reported. Also, the first illustrations of pottery from Gramalote were published (Briceño and Billman 2008). The latest fieldwork seasons were directed by Prieto from 2010 to 2014, who introduced the first contextual evidence that supports the fact that small-scale agriculture was an important activity developed by this early Ceramic people (Prieto 2015). Gramalote was studied as a maritime community with varied economic subsistence activities and consumption at the household level as reflected in the diverse archeological record (Prieto 2015).

During excavations directed by Prieto, Gramalote was divided into four units (I – IV) to spatially organize data coming from the field (Figure 3). Different archeological contexts and features were uncovered in each unit (Prieto 2015). Several hearths associated with floor contexts were excavated in different occupational levels at the site. Within them, ten carbonized fragments of *Tillandsia* sp. were submitted for radiocarbon dating (Prieto 2014). Based on these radiocarbon dates, Gramalote was occupied between 1500 and 1200 BCE, which is the early portion of the Initial Period in the Moche valley. Three occupational phases were identified based on stratigraphic analysis and correlation with radiocarbon samples from features recorded during the excavations (Prieto 2015). During phase 1, the inhabitants occupied natural depressions on the top of the terrace, and the architecture was oriented 40 degrees east of north. During phase 2, the population increased, occupation extended beyond the depressions, the domestic architecture was reoriented toward the north and a large public architectural compound was built in the east sector of the site. During phase 3, the domestic structures maintained their north orientations and new feature types, rectangular subterranean storerooms, were recorded (Prieto 2015).

Figure 3 General view of Unit IV of the Gramalote site

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CHAPTER II

THE ETHNOBOTANY OF THE FISHING COMMUNITY OF HUANCHACO

II. 1 Introduction

The study of subsistence strategies focused on the interactions between coastal communities and marine resources in South America is well documented. Diverse investigations have been conducted that include the assessment and conservation of trophic interactions (Neira and Arancibia 2004; Netto and Pereira 2009; Zappes et al. 2013), socio-ecological systems at different fisheries scales (Defeo and Castilla 2012), local knowledge of fishermen about marine resource biology and sustainable management (Castellanos-Galindo et al. 2017; Gerhardinger et al. 2006; Thompson and Volpedo 2018) and gender roles in fishery economies (Harper et al. 2017).

Botanical resources have also contributed to subsistence in coastal communities. A few studies have emphasized the importance of plant knowledge in South American coastal communities. In Colombia, agriculture and forest use have played a main role in the economy of the coastal people of Chocó (Galeano 2000). Galeano (2000) determined that although the community's lifestyle has been changing and most of the forest knowledge is possessed by the elders, plants are still used for six subsistence purposes. Knowledge erosion on the use of food plants has been identified in Afro-descendant communities in the Colombian Caribbean coast (Pasquini et al. 2018). Food uses are still known but their current use is limited and restricted to older generations. In Brazil, two Caiçara communities from the Atlantic forest coast are known to have depended on food, medicine, handicraft and construction of houses and canoes from native vegetation for their subsistence (Hanazaki et al. 2000). Although external economic changes affected their local livelihoods, local plants are frequently used by the Caiçara fishers and farmers thanks to their seasonal availability, acceptance in local markets and dynamism in knowledge (Peroni et al. 2008).

In northern Peru, ethnobotanical research on coastal communities have shown that a diverse number of edible plants from the Passifloraceae, Apiaceae, Euphorbiaceae, Moraceae and Lauraceae families are frequently used in cooking practices (Borges and Peixoto 2009; Giraldi and Hanazaki 2014). In addition, plants are used to treat diseases. People collect wild plants or purchase herbs in local markets for medicinal purposes (Bussmann and Sharon 2009). The most utilized medicinal plants in northern Peru include specimens from the Asteraceae Malvaceae, Myrtaceae, Piperaceae, Phyllantaceae and Rubiaceae plant families (Bussmann and Sharon 2009; Bussmann and Glenn 2010). However, ethnobotanical investigations are still scarce in this region, specifically in coastal communities with marine-oriented economies such as fishing where people use plants to complement their subsistence activities.

In the study of traditional ecology knowledge (TEK) on plant uses, intracultural variation in plant knowledge is often correlated with different personal attributes that influence daily behavior. Gender, age, language, education, and lifestyle are attributes that have been commonly shown to be associated with individual levels of TEK (Aguilar-Santelises and Castillo 2015; Begossi et al. 2002; Camou-Guerrero et al. 2008; de Almeida et al. 2012; de Albuquerque et al. 2011; Doyle et al. 2016; Quinlan and Quinlan 2007; Voeks and Leony 2004; Case et al. 2005). Gender and age are especially important attributes in studies of intracultural variation of plant TEK because they are often used to determine roles within a community, which impacts the amount of time people engage with plants for different uses. Some tendencies have been found that women and elderly people are the most knowledgeable in rural groups with similar division in labor, settlements and lifestyles (de Albuquerque et al. 2011; Doyle et al. 2016; Quinlan and Quinlan 200; Voeks 2007).

This study furthers the research on ethnobotany of coastal communities and intracultural variation of useful plant knowledge by examining the role of botanical resources for subsistence in the fishing community Huanchaco. An ethnobotanical survey was conducted with members of the community. The objectives of this ethnobotanical research are: 1) to determine the use of botanical resources for daily activities among a coastal and fishing cultural group and 2) how that knowledge is associated to age and gender attributes.

II. 2 Methods

Unstructured interviews and participant observation techniques (Spradley 1980) were conducted with 19 male and 21 female members of the fishing community. After receiving informed consent (IRB 2017-0033M), each participant was interviewed to learn about their knowledge regarding the use of plants. The list of formulated questions to each participant is attached as Appendix 1. If the participant reported that they were familiar with the plants growing in and around Huanchaco for any of their daily subsistence activities then, they were asked to provide a list of the plants and their uses. Additionally, they were questioned about the specific locations where they accessed the plants, including whether or not they were collected from the agricultural fields or the green patches of wild vegetation in the river valleys. Questions on plant processing for each use were also posed, including which part of the plant is used and how it is processed. The used data collection form is attached as Appendix 2 at the end of this manuscript. Finally, demographic information about each participant was collected.

The collected data were categorized according to the participants' classification as *medicine* for plants that are used to treat and cure diseases, *food* which are edible plants that are cultivated or gathered in wild conditions and exclude food plants that are bought in markets, and *industrial* that includes plants which function for construction or personal hygiene. Guided by participants, botanical specimens were collected from the agricultural fields and the vegetation along the river valleys surrounding Huanchaco (Figure 2). The collected plants were taxonomically identified by the botanist Fiorella Villanueva, research assistant in the Magdalena Pavlich Herbarium at Universidad Peruana Cayetano Heredia, Lima, Peru, and donated to their collection.

II. 3 Data Analysis

The descriptive statistical analysis was computed in Microsoft Excel 2010. This analysis included the participant demographics, such as age, gender, and the percentage of interest of participants in continuing to learn and transmit information about plant uses to other members of the fishing community. To identify the relative importance of the botanical species, the use value (UV) (Phillips et al. 1994) was calculated using the formula $UV= \Sigma U/n$, where U is the number of uses for a plant species mentioned by each participant and n is the total number of participants.

Additional statistical analyses were performed in R 3.4.4 (R Core Team 2018). A p-value of less than 0.05 was considered to be statistically significant. A Kruskall-Wallis test was used to compare the differences between the UVs assigned to the plants by men and women, and old and young participants. Pearson's correlations were applied to determine if there was a correlation between age and the number of plants recognized by the participants. Finally, to evaluate the agreement in the use of plants in the different categories of uses among the participants, the informant consensus factor (Fic) (Heinrich et al. 1998) was calculated using the formula Fic=Nur-

Nt/Nur-1, Nur is the number of uses for a category and Nt is the number of plant specimens used for that category by all the participants.

II. 4 Results

A total of 29 botanical specimens (Table 1) was identified as useful plants in the fishing community of Huanchaco. Of these plants, 41.38% are used as medicine including *Alternanthera halimifolia*, *Baccharis salicina*, *Bidens pilosa* and *Gossypium barbadense*; 37.93% as food including *Cucurbita maxima*, *Ipomoea batatas*, *Passiflora edulis* and *Zea mays*; and 20.69% as industrial products, including *Acacia macracantha*, *Lagenaria siceraria*, *Luffa operculata* and *Schoenoplectus californicus*. The majority of the useful plants is characterized as herbs (31.03%), followed by trees (24.14%), shrubs (20.69%), and vines (17.24%). Fabaceae, Asteraceae and Cucurbitaceae were the most dominant plant families.

Most of the useful botanical resources are herbs from the Asteraceae family that the members of the fishing community use for medicinal purposes (Figure 5). Leaves and flowers are added to boiled water for the preparation of infusions that help to reduce a variety of conditions including inflammation after giving birth; treat breast cancer, hepatitis and anemia; or to serve as a depurative, febrifuge and sudorific (Table 1). Many of the food plants are fruits from diverse families. *P. americana*, *P. edulis*, *Z. mays* and *P. lucuma* are used by all members of the community (Table 1) as a part of daily food consumption.

Most participants in this study are between 31 and 43 years old (35%), followed by individuals 44-56 years of age (30%), 18-30 years old (22.5%) and 57 years of age or older (12.50%). Women represent 52.5% of the total participants (Table 2). In respect to the potential for intergenerational transmission of knowledge, 40% of the members of the fishing community are interested in continuing to use plants they currently cultivate or gather during their daily activities; 25% are neutral and 35% are uninterested (Table 2).

The UV (Table 1) of the different botanical specimens shows that *I. batatas*, *C. maxima*, *Prosopis pallida*, *Persea americana*, *P. edulis*, *Z. mays* and *Pouteria lucuma* (1.00) are the most commonly used and important species in the fishing community of Huanchaco, most of them being food plants. In contrast, plants identified with the lowest UV include and *Tiquilia dichotoma* (0.23) and *Encelia canescens* (0.30) which are both occasionally collected to prepare medicinal teas. On the average, women had higher UVs (0.80) for the plant species than men (0.54). The differences between the UVs by woman and men were statistically significant according to the Kruskall-Wallis test (chi-squared=5.07, p-value=0.02). Women are more knowledgeable about medicinal and industrial plants as compared to men (Figure 5 and 6), while both men and women are familiar with food plants. An overall positive correlation between age and plant knowledge (r=0.88, p-value= 9.82e-14) was found with significant differences between UVs among old and young participants according to the Kruskall-Wallis test (chi-squared=21.57, p-value= 8.007e-05). Older people are more knowledgeable than younger people, especially within the medicinal and industrial plant use domains.

Women collect medicinal plants and process the plant parts to prepare teas that help cure specific health conditions. Different plant parts are washed and used in the preparation of medicinal infusions and decoctions, such as flowers of *A. halimifolia* consumed to reduce postpartum swelling; flowers, leaves and stems of *B. pilosa* to treat breast cancer; leaves of *B. salicina* for stomach ache, and fruits of *Jacaranda acutifolia* for cleansing the womb after birth (Table 1). In addition, women use brown cotton fibers from *G. barbadense* to treat *susto*, a culture-bound illness associated with fright. The brown cotton fibers are collected from wild cotton plants that grow in and on the edges of agricultural fields. The healer pass the cotton fibers, while praying, along the body of the ill person to remove the evil spirits that are causing the disease from the body. TEK on the use of cotton to treat *susto* is well known within the members of the fishing community and most of the general population of Huanchaco.

Industrial plants are used as construction materials and as cleaning products by women and men (Figure 6). *P. pallida* and *A. macracantha* are sources of wood for construction in northern Peru. *P. pallida* is also planted along the borders of agricultural fields to shade crops and as a wind break. *A. macracantha*, known as *faique*, is also used to protect agricultural fields from animal invasions due to the long spines that grow along their branches. Another industrial plant is *L. operculata*, commonly called *jaboncillo*, which dried seeds are used by women and men as a natural soap or shampoo for washing hair. According to the informants, it improves the hair's strength, color and brightness. However, the use of *jaboncillo* has been affected by the introduction of inorganic products for hair treatment that are easy to use and economically accessible, resulting in a loss of TEK. Young people have never heard of this use and, within the adults, mostly women above 57 years old still use this plant but with less frequency. Finally, *Sapindus saponaria*, locally known as *choloque*, is used mainly by women in the fishing community as a natural soap for washing cloth and ceramic containers, and by men as poison for fishing activities in fresh water environments. Finally, *S. californicus* is exclusively used by men, mostly adults, for sea vessel construction, plant TEK that has conveyed across generations.

When analyzing knowledge sharing for each use category, low Fic values, near 0, indicate no exchange of information about a use category within the members of the community; whereas high Fic values, near 1, denote an exchange of information. Results show a high degree of shared knowledge among the participants with Fic values from 0.95 for medicinal plants to 0.98 for food

Table 1 List of plants used by the fishing community of Huanchaco.

he: herb, sh: shrub, tr: tree, vi: vine, re: reed, gr: grass, fi: fiber, fr: fruit, fl: flower, le: leaf, pl: whole plant, st: steam, tu: tuber

I: industrial, M: medicinal, F: food.

Family	Scientific name	Local name	Habit	Part used	Use	UV
Amaranthaceae	*Alternanthera halimifolia*	Flor blanca	he	fl	M: inflammation after birth	0.50
Asteraceae	*Baccharis salicina*	Chilco	sh	le	M: stomach ache, antirheumatic, prevent spasms	0.53
Asteraceae	*Bidens pilosa*	Cadillo	he	fl, le, st	M: breast cancer, hepatitis, nephritis, urinary infections	0.45
Asteraceae	*Encelia canescens*	Camporco	sh	le, st	M: promote lactation after giving birth, diuretic	0.30
Asteraceae	*Sonchus oleraceus*	Cerraja	he	fl, le, st	M: liver disease, irritation, depurative	0.33
Bignoniaceae	*Jacaranda acutifolia*	Arabisca	tr	fr	M: cleansing womb after childbirth	0.33
Boraginaceae	*Tiquilia dichotoma*	Flor de arena macho	he	st	M: inflammation, depurative	0.23
Boraginaceae	*Tiquilia paronychioides*	Flor de arena hembra	he	st	M: inflammation, depurative	0.40
Convolvulaceae	*Ipomoea batatas*	Camote	he	tu	F	1.00
Cucurbitaceae	*Cucurbita maxima*	Zapallo	vi	fr	F	1.00
Cucurbitaceae	*Lagenaria siceraria*	Checo	vi	fr	I: dried fruits are used as container	0.93
Cucurbitaceae	*Luffa operculata*	Jaboncillo	vi	fr	I: hair wash	0.50

Table 1 Continued

Family	Scientific name	Local name	Habit	Part used	Use	UV
Cyperaceae	*Schoenoplectus californicus*	Totora	re	re	I: construction of fishing boats	0.80
Fabaceae	*Acacia macracantha*	Faique	tr	pl	I: fence to avoid property invaders	0.43
Fabaceae	*Cajanus cajan*	Frejol de palo	sh	fr	F	0.73
Fabaceae	*Lablab purpureus*	Lenteja bocona	vi	fr	F	0.85
Fabaceae	*Medicago sativa*	Alfalfa	he	le	M: anemia, wound healing	0.73
Fabaceae	*Prosopis pallida*	Algarrobo	tr	pl	I: fence between agricultural fields, windbreaker	1.00
Fabaceae	*Mimosa albida*	Tapa tapa	sh	le, st	M: urinary and digestive track inflammation	0.40
Lamiaceae	*Mentha spicata*	Hierba buena	he	le, st	F: drinks and cooking	0.85
Lauraceae	*Persea americana*	Palta	tr	fr	F	1.00
Malvaceae	*Gossypium barbadense*	Algodón pardo	sh	fi	M: *susto* and evil eye	0.70
Myrtaceae	*Psidium guajava*	Guayaba	tr	fr	F	0.98
Passifloraceae	*Passiflora edulis*	Maracuya	vi	fr	F	1.00
Poaceae	*Zea mays*	Maiz	gr	fr	F	1.00
Sapindaceae	*Sapindus saponaria*	Choloque	tr	fr	I: clothes wash	0.45
Sapotaceae	*Pouteria lucuma*	Lucuma	tr	fr	F	1.00
Solanaceae	*Cestrum auriculatum*	Hierba santa	sh	le	M: febrifuge, sudorific	0.35
Solanaceae	*Solanum* sp.	Tomatillo silvestre	he	fr	F	0.95

Variable	**Percentage (%)**
Age	
57 and above	12.5
44-56	30
31-43	35
18-30	22.5
Gender	
Female	52.5
Male	47.5
Interest in useful plants	
Interested	40
Neutral	25
Uninterested	35

Table 2 Participant demographics

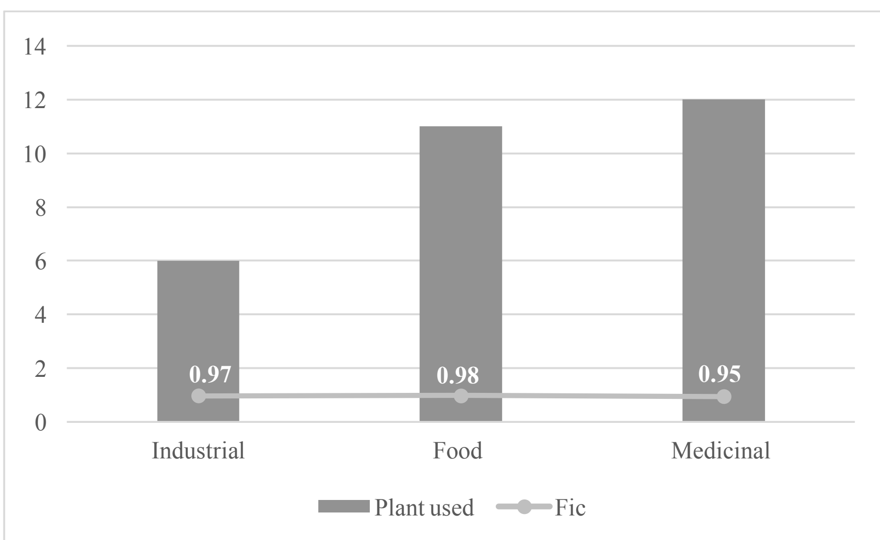

Figure 4 Informant Consensus Factor (Fic) for the four use categories

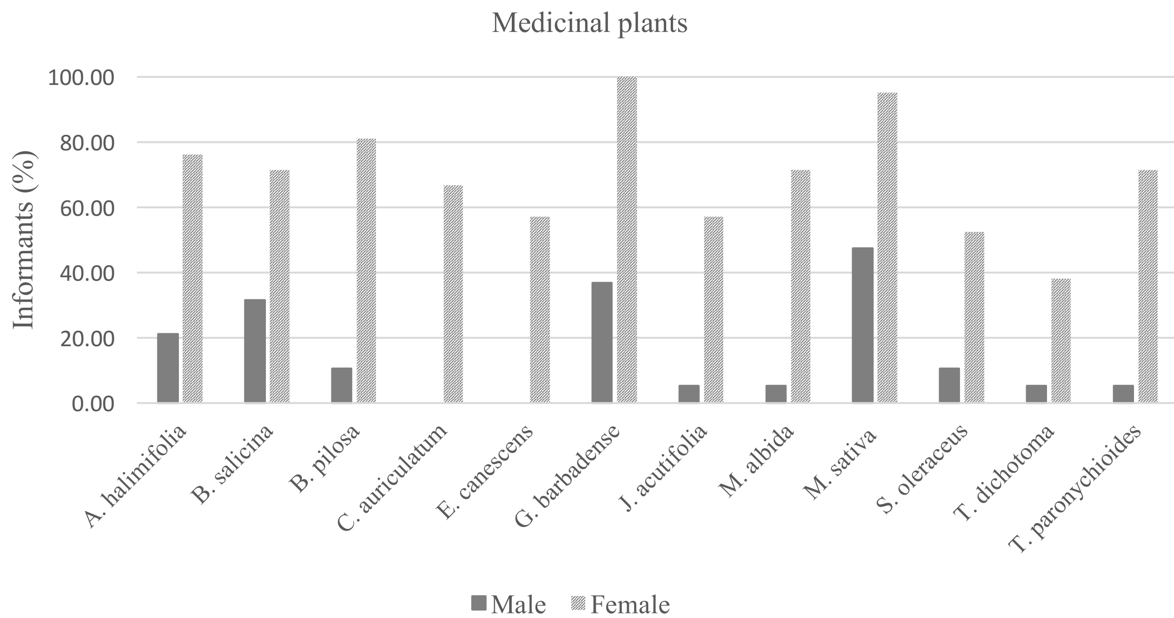

Figure 5 Gender distribution of traditional ecological knowledge in the domain of medicinal plants.

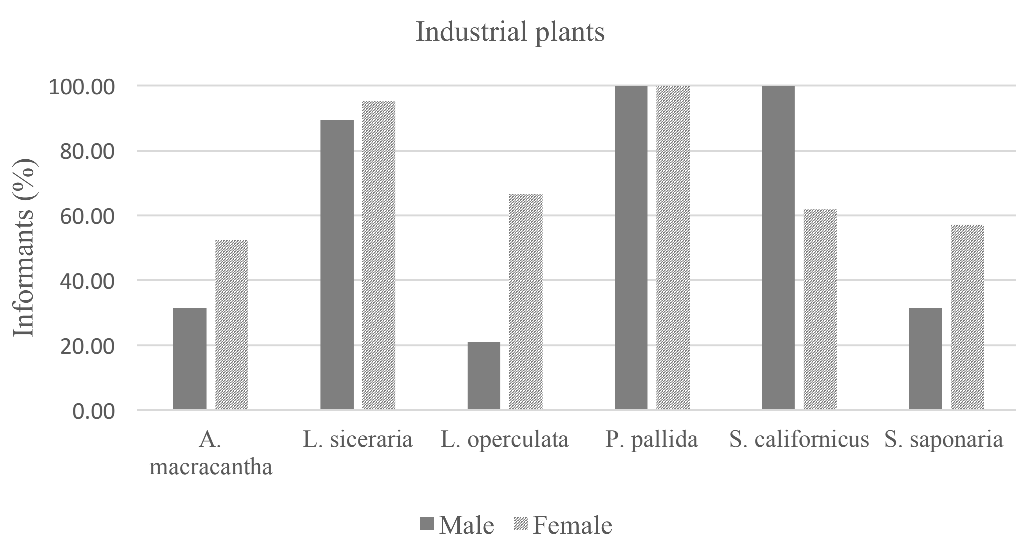

Figure 6 Gender distribution of traditional ecological knowledge in the domain of industrial plants.

plants, and industrial plants in between at 0.97 (Figure 4).

II. 5 Discussion

Despite the social changes resulting from globalization, such as a decrease in the community's interest in using plants for medicinal or industrial purposes and an increase in preference for buying food plants at the local market, TEK related to plant uses is part of the Huanchaco's cultural heritage and continues to play an important role in their daily subsistence practices.

II.5.1 Use of Botanical Resources in the Coastal Community

As noted, people use plants for food, industrial and medicinal purposes with a TEK that has been preserved across generations. The paleoethnobotanical record of the Gramalote site supports a persistence of TEK in the use of plants since prehispanic times (Paredes 2018). Macrobotanical remains such as roots, stems, leaves, fruits and seeds (Ubillus 2014) and microbotanical evidence such as pollen (Paredes 2018), starch and phytoliths (Villanueva 2014) of useful plants, including food, medicinal and industrial plants that are still being used today by the fishing community, have been recovered from domestic and ceremonial contexts of the site (Prieto 2015). There is evidence of continuity through time related to the use of *Z. mays* and *P. lucuma* as food, and *S. californicus* and *P. pallida* as industrial plants since approximately 3500 years ago. In addition to the Initial Period paleoethnobotanical record, the historical record provides evidence on the use of those resources during the colonial period (Gillin 1947; Ramírez 1996), and this study documents its continued use in the present in northern Peru. Today, seven plants (UV=1) are recognized and used by all participants of the fishing community mainly for food purposes, and age and gender differences are primary factors that influence the distribution of TEK about the use of industrial and medicinal plants.

The local agriculture promotes the continuity of high use value plant TEK through fishing community members having direct daily interactions with food plants. *Z. mays*, *I. batatas*, and *P. edulis* are cultivated in the agricultural fields and harvested to complement the protein-rich marine foods. *Z. mays* and *I. batatas* have been considered two important sources of carbohydrates for coastal communities in northern Peru since prehispanic times (Bonavia et al. 2017; Haas et al. 2013). *P. edulis* is consumed by modern northern communities as fresh fruits or processed and combined with other foods due to its high sugar content (Tantaleán 2016). Although, industrial development in the Huanchaco area has affected the ecological conditions of the arable lands by reducing the quality and quantity of the production of fruits and vegetables, more limited agriculture practices still take place. *P. edulis* and *Z. mays* are the most popular cash crops and are taken to Trujillo city, the capitol of La Libertad region that is 10 km away from Huanchaco (GeoDatos 2017), to be sold in a bigger market that generates greater profits. Also, the development of new businesses to satisfy the tourism demand is changing the Huanchaco's economy and reducing the practice of agriculture in the town. Today, only 40% of the members of the fishing community are interested in continuing to cultivate or gather plants, most people prefer to buy food plants such as *I. batatas*, *C. maxima*, *P. americana*, and *Psidium guajava* for their own consumption or for the tourists' consumption in restaurants or hotels, as it is cheaper and less time consuming.

The sunken gardens are exclusive habitats for *S. californicus*, which have been used to construct sea vessels and mats, and more recently souvenirs that have provided extra sources of income (Paredes and Hopkins 2018). Other industrial plants such as *P. pallida* and *A. macracantha* grow within the agricultural fields and are used to protect the crops. In addition, people take advantage of their wood and construct tools including *A. macracantha* mace clubs used to facilitate offshore fishing and *L. siceraria* containers used for water storing (Prieto 2015). From the disturbed areas in and around the agricultural fields, plants are still collected and consumed as traditional medicine. However, some medicinal plants such as *Tiquilia dichotoma*, *Encelia canescens* and *Sonchus oleraceus* were identified with the lowest use values. These low values may be associated with processes of TEK loss (Stoffle et al. 1990; Pieroni 2011). In Huanchaco, the processes of modernization and globalization are resulting in generational changes in lifestyle, including medicinal plant use. In addition, urbanization has reduced the availability of disturbed areas where medicinal plants grow which may be associated with their low use values. Benz et al. (1994) explained that the use of a plant resource is a function of its abundance, with more abundant species being more extensively used. Therefore, the low use value of some medicinal plants can also be related to their scarcity or the reduction of their populations observed in recent years.

II.5.2 Intracommunity Variation of TEK Associated to Age Attribute

The general tendency that TEK is positively associated with the participant's age (Begossi et al. 2002; Voeks and Leony 2004) is supported by this study. Elder members are more knowledgeable about plant uses than younger members of the fishing community and the explanations for this intracultural variation are associated with aspects of modernization. The increasing access to modern services such as schools and health care facilities and integration into the market economy impact the distribution of TEK in rural communities of developing countries (Hopkins 2015; Doyle et al. 2016). In Huanchaco, the access to hospitals and pharmacies contribute to a reduction in the practice of traditional medicine. For example, younger generations prefer today to buy industrially produced wound care products instead of using *Medicago sativa* extract to promote wound healing. They claim that they spend less time going to the pharmacy than collecting and processing plants. On the other hand, most elder members still rely on TEK for medicinal purposes emphasizing the healthier properties of the natural resources. The reasons for their preference is based on their limited exposure to external influences and their life experiences. Older people have had more time to acquire TEK of medicinal plants and experience their healing properties, and have more time at their disposal than younger people (Voeks and Leony 2004; Voeks 2007). Similarly, industrial plants are mostly used by elder people. They continue to use *jaboncillo* to wash their hair and *choloque* to wash cloth, whereas younger people prefer to buy shampoo and soap in the local market.

II.5.3 Intracommunity Variation of TEK Associated to Gender Attribute

The strong division in labor in the fishing community of Huanchaco influences the relationships men and women have with the useful plants (Toledo and Galeto 2007; Voeks 2007) and contributes to the intracultural variation of TEK in the group. This was evident in the higher number of industrial and medicinal plants known by women as compared to men (Figure 5 and 6). In rural regions, increases in the availability of wage labor jobs typically carried out by men and the associated processes of acculturation among the male population have contributed to women having an increasingly important role as primary conveyors of TEK of plant uses (Heckler 2002). There is also a gendered division of space with men typically engaging in activities, such as fishing and livestock herding, that takes them to less disturbed habitats distant from their households; whereas women often manage local resources in highly disturbed habitats, such as gardens close to their homes (Momsen 2004). Women in the fishing community play a primary role in the acquisition, preparation and administration of most medicinal and industrial plants. For instance, women collect *E. canescens* leaves and stems and prepare them in an infusion that they then drink to promote lactation after giving birth. Women also play a primary role in food preparation and administration, however both men and women play an active role in the acquisition of food plants, particularly from the agricultural fields or the market.

II.5.4 Age and Gender influence plant knowledge sharing

A high degree of shared knowledge among participants is observed in each use category (Figure 4). People share their TEK during their daily routines, especially while curing illness, cooking food, cultivating crops and fishing for marine resources. Often elderly people are consulted about which herbal remedies to use when a relative or a known person becomes ill (Hopkins et al. 2015). They are well recognized and respected people in the community, with a traditional ecological knowledge that is locally considered superior to the younger generations' knowledge. Food recipes are commonly shared especially within groups of women that cultivate, gather, buy and process food plants together. Younger generations consult with older generations on cooking techniques and food preferences. In addition, men show their children how to cultivate *totora* reeds and how to process them to construct the popular *caballitos de totora* (Paredes and Hopkins 2018). During this process, people also learn how to identify and remove plants that invade the sunken gardens and affect the growth of the reeds. Plant TEK is acquired and transmitted among the members of the community and its distribution is influenced by age and gender.

II. 6 Conclusion

Although processes of globalization and modernization have influenced their lifestyle, Huanchaco fishermen and their families still rely on some plant TEK for daily activities. The use of medicinal plants to treat illnesses, industrial plants for construction and personal hygiene, and food plants to complement their protein-rich diet suggest that botanical resources are also important in coastal communities and should be considered in the study of their subsistence strategies.

Intracultural variation of knowledge associated with gender and age attribute was identified within the fishing community. Women and elder people are the most knowledgeable about medicinal and industrial plants except for the use of *totora* reeds, which is the purview of adult men. The influence of gender attribute in the division of labor practices, particularly the role of women as primary healthcare givers, the access to modern services, and the influence of age on the accumulation of plant use TEK through life experience and greater free time among the elderly produce the intra-cultural variation in knowledge within the coastal group. Age and gender influence the distribution of plant TEK among the members of the community.

This research recognizes the cultural value of the relationships between the fishing community and the botanical resources that grow in Huanchaco. The acquisition and transmission of plant TEK for food, medicinal and industrial purposes among the members of this coastal community has contributed to the development of human subsistence in northern Peru through time.

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CHAPTER III

PALEOETHNOBOTANY OF THE EARLY INITIAL PERIOD OF GRAMALOTE IN NORTHERN PERU*

III. 1 Introduction

Symbiotic relationships between people and plants have played an important role in the change in subsistence strategies through time, such as the shift from hunting and gathering to agriculture production (Bellwood 2005). The paleoethnobotanical record indicates that food production began during the early Holocene in the Neotropics (Piperno and Pearsall 1998; Piperno 2011) which resulted in subsequent demographic, social, economic and technological changes among communities where crops appeared (Dillehay and Piperno 2014). Although prehispanic maritime communities greatly depended on the exploitation of marine resources (Moseley 1975) these communities were also exploiting and modifying plants during the early Holocene (Piperno and Pearsall 1998). Archaeological evidence that support this pattern comes from Peru, where a large number of prehispanic communities settled along the coast and utilized both marine and inland agriculture subsistence strategies (Quilter and Stocker 1983; Sandweiss 2009). Additionally, Peru is considered a center of plant domestication in the Americas (Gepts 2004; Larson et al. 2014) making it an important study area to understand the increasingly complex relationship that occurred by between people and plants over time.

In northern Peru, coastal peoples have been cultivating plants since about 10,000 years ago (Dillehay et al. 2007; Piperno and Dillehay 2008). Industrial plants such as cotton (*Gossypium*

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barbadense L.) and gourds (*Lagenaria siceraria* (Molina) Standl.), and food plants such as chili peppers (*Capsicum baccatum* L.), lima beans (*Phaseolus lunatus* L.), lucuma (*Pouteria lucuma* (Ruiz & Pav.) Kuntze), avocado (*Persea americana* Mill.), pacae (*Inga feuilleei* DC.) and squash (*Cucurbita moschata* Duchesne) were cultivated during Late Preceramic (3000-1800 BCE) by maritime communities (Bonavia 1982; Pozorski 1982; Shady 2006; Bonavia et al. 2017). The cultivation of these plants complemented the marine-resource-based economy that coastal peoples had during the Preceramic period (Pozorski 1982; Moseley 1975; Pozorski and Pozorski 1979).

During the Ceramic Initial Period (1800–800 BCE), there was an increase in food plants utilized as a result of cultivation of larger areas through irrigation agriculture and a development of complex settlements along the north coast of Peru (Burger 1992; Nesbitt 2012; Pozorski 1979). Initial Period maritime communities along the Peruvian coast were dynamic entities that emphasized inter-household cooperation to perform subsistence and non-subsistence activities (Prieto 2015). However, the Initial Period has been studied with a focus mainly on the social dynamic and economic interactions within maritime settlements in northern Peru (Pozorski 1979; Pozorski and Pozorski 1979). Studies about direct relationships between humans and plants, as manifested in the paleoethnobotanical record, are scarce despite the good preservation that the western coastal plain of Peru provides for these remains.

The study of abundant fish faunal remains of the Initial Period site of Gramalote supports the interpretation that its inhabitants had a strong marine-oriented economy (Prieto 2015). Also, a great diversity of household industries such as basketry, carving of seabird and marine mammal bones and drilling shells, production of small ceramic objects and production of red pigment is evidenced in the archaeological record (Prieto 2014). Additionally, several botanical remains have been recovered during excavations suggesting that these people also had access to and used plant resources (Prieto 2015). To test this hypothesis, the objective of this investigation was to conduct a paleoethnobotanical analysis with the focus on reconstructing the pollen record of Gramalote. Previously identified macro and microbotanical remains (Ubillus 2014; Villanueva 2014) were also considered. The analysis of diverse botanical proxies helps to develop a more comprehensive understanding of the relationships between humans and plants during the early Ceramic period at Gramalote.

III. 2 Methods

In May 2015, a 100-cm thick sediment profile was excavated in a Public Architectural Compound in Unit IV, where the early Initial Period deposits were 75-cm thick with two identified occupational phases: phase 3 (1300–1200 BCE) and phase 2 (1400–1300 BCE). A total of 20 sediment samples was collected for palynological analysis following Bryant's and Holloway's (1983) guidelines for preventing any contamination between strata. After cleaning the face of the profile, each sample was collected, using sterile equipment from every 5 cm in the Initial Period deposits, which resulted in eight samples per occupational phase. In addition, four sediment control samples were collected from the surface using the "pinch method" (Adam and Mehringer 1975) to determine the modern pollen rain and to check for vertical movement. Each sample was placed in a sterile plastic bag and a small amount of alcohol was added to prevent any microbial destruction until the samples could be processed. All samples were labeled with the provenience information (project, occupation, sample number, and depth). The sediment samples were later processed in the Pollen Laboratory at Texas A&M University. For each sample, 10 grams of sediment per sample was sieved through a stainless steel screen to remove debris larger than 150 um. Tracers (*Lycopodium* spores #177745) were added to each sample to check for pollen lost during the chemical process and to enable pollen concentration calculations. Next, 15% hydrochloric acid was added to dissolve carbonates and then 48% hydrofluoric acid to dissolve silicates. The last process was acetolysis (Erdtman 1960) that was used to reduce the organic materials. The pollen residue was mixed with a zinc bromide heavy liquid (specific gravity 2.0) to separate lighter particles, including pollen grains, from the heavy inorganic fraction. The light fraction was rinsed in distilled water and alcohol, stained with safranin-0 and stored in vials. The palynomorphs were mounted in glycerin and identified using the Peruvian modern pollen reference collection (Huamán 2016). Quantitative data (percentage composition) were computed from counts of 200 grains per sample.

Because the Public Architectural Compound was a ceremonial facility, I expected it to contain botanical evidence within its sediments that had an important role in the subsistence activities of the Gramalote community. For this reason, all the identified botanical remains were classified according to their most popular use by people. This classification was based on the modern plant use categories identified in chapter II and in Brack's (1999) compilation of useful plants of Peru. Taxa were grouped as "food" for edible plants; "reed" for plants that can be used as material for dwelling construction and to elaborate baskets, matting, and boats; "wood" for plants that are good sources of wood for fuel or construction; and "wild plant" which include plants that have not been domesticated according to the reference.

III. 3 Results

In total, 40 taxa were identified (Appendix 3) based on the Angiosperm Phylogeny Group III system (The Plant List 2017). Within them, taxa with a known use were selected and are shown in the pollen diagrams.

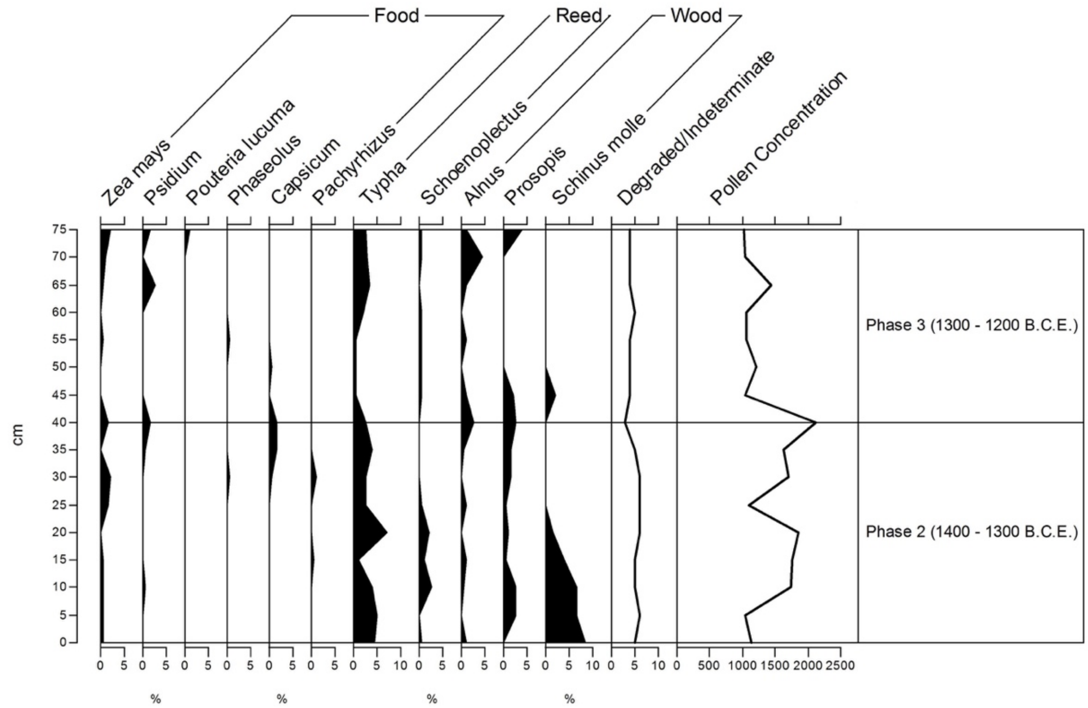

Figure 7 Relative abundance of pollen taxa grouped as food, reed and wood. Reprinted with permission from Paredes 2018.

According to Figure 7, greater pollen abundance is seen in phase 2. However, during the early Initial Period, considering both occupational phases, *Zea mays* L. (maize), *Capsicum* (chili pepper), *Pachyrhizus* (ajipa), and *Psidium* (guayaba) pollen are the most predominant types within the food group. *Typha* (enea) and *Schoenoplectus* (totora) pollen support the presence of reeds. Pollen from trees species used for wood included *Schinus molle* L. (molle) in highest abundance, but *Alnus* (alder) and *Prosopis* (mesquite) were also present. Wild plant pollen types are present with greater pollen abundance as compared to the other categories during the two occupational phases (Figure 8): Poaceae and Asteraceae pollen are the most predominant taxa. Amaranthaceae, *Ambrosia* (artemisa), and Solanaceae show a diverse pollen frequency over time. On the other hand, *Urocarpidium* (malva), Anacardiaceae and Convolvulaceae are the least abundant during both occupation periods.

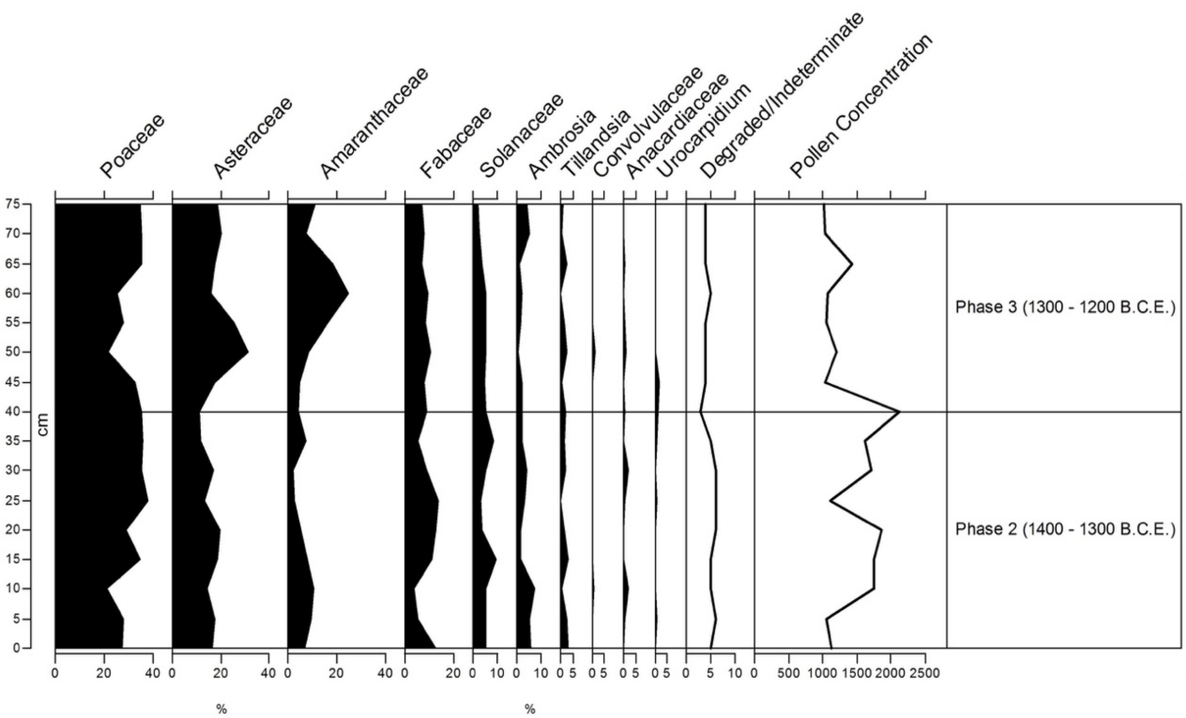

Figure 8 Relative abundance of pollen taxa grouped as wild plants and some plants that could only be identified to the family level. Reprinted with permission from Paredes 2018.

Dean (1991) suggests that when the unidentifiable pollen grains in a sample are greater than 10% it generally indicates poor preservation. Bryant and Hall (1993) conclude that one should be cautious of pollen data from archaeological sites when fossil pollen concentrations levels fall below 1,000 grains/gram. In this study, the percentage of degraded and indeterminate pollen is less than 7% and pollen concentrations vary between 1,000 and 2,500 grains/gram. Even though, the alkaline soils of this region affected the pollen preservation and richness, results meet the previously recommended requirements and thus can contribute new information to the Peruvian pollen record.

Table 3 shows the pollen abundance and concentration values of the surface samples. Taxa identified only in the modern flora include *Sonchus*, a wild plant, and *Acacia*, which is an important source of wood. However, some taxa found in past occupation levels are still growing in the area today such as *Psidium* and *Pouteria lucuma* which are food plants; *Typha* and *Schoenoplectus* which are reeds; *Alnus* and *Prosopis* that are used as wood sources; and species of Poaceae, Amaranthaceae and, Fabaceae considered wild plants. Pollen concentrations of the surface samples are greater, between 2,000 and 3,500 pollen grains/gram, in comparison to sediment samples from the early Initial Period. However, in general, it appears that the low pollen concentration values of all the samples are caused partly by the alkaline sediments characteristic of this coastal desert and by the low pollen yields of the sparse vegetation.

III. 4 Discussion

III.4.1 PHASE 2 (1400–1300 BCE)

During this occupation, people had access to a variety of food plants that have been reported in paleoethnobotanical studies from earlier sites. For example, *Zea mays*, commonly known as maize, and *Pachyrhizus*, known as ajipa, had been sources of carbohydrates since the Late Preceramic for coastal people (Haas et al. 2013; Winker 2011). Pollen grains, macrobotanical remains (Ubillus 2014), and starch grains (Villanueva 2014) support their presence and perhaps consumption during the early Initial Period in Gramalote. Maize pollen grains are produced in enormous quantities and are pollinated by wind, 95% percent of these grains falls within 10 meters of the plant (Jarosz et al. 2003) and the other 5% do not go much farther. Therefore, its low pollen abundance in this occupation suggest that this plant could have been obtained by trading with inland sites that have the soil and weather conditions necessary for its cultivation.

Table 3 Surface sample pollen percentages and pollen concentrations. Reprinted with permission from Paredes 2018.

	Sample Number			
Selected Pollen Taxa	#17	#18	#19	#20
Poaceae	29.00%	54.00%	51.00%	44.00%
Asteraceae	25.50%	10.00%	12.00%	17.50%
Fabaceae	12.50%	11.50%	8.50%	9.50%
Amaranthaceae	8.00%	5.50%	5.50%	6.00%
Ambrosia	3.00%	1.50%	4.50%	3.00%
Solanaceae	3.00%	2.00%	2.50%	4.00%
Alnus	1.50%	2.00%	3.50%	2.50%
Tillandsia	2.50%	2.00%	1.50%	1.00%
Typha	2.50%	1.50%	2.00%	0.50%
Prosopis	2.50%	0.50%	1.00%	0.50%
Psidium	0.50%	1.50%	1.00%	1.50%
Acacia	0%	0.50%	0.50%	0.50%
Malvaceae	1.50%	0%	0%	0%
Sonchus	1.50%	0%	0%	0%
Schoenoplectus	1.00%	0%	0%	0%
Pouteria lucuma	0%	1.00%	0%	0%
Unknown	0%	1.50%	0%	5.50%
Number of pollen grains / gram of sediment	2,660	3,255	2,030	2,060

Pachyrhizus has edible tuberous roots that grow in tropical lowland forests (Sorensen et al. 1997), which are found in central Peru. Thus, because of the tropical habitat in which it grows and its low pollen abundance in Gramalote, the presence of ajipa is considered a result of trade. Non-local artifacts such as anthracite objects, cinnabar, malachite and ceramic wares (Prieto 2015) were found in the site supporting the idea of an active trading network. Other food plants are *Capsicum* (chili pepper), identified in the pollen and starch record (Villanueva 2014), and *Psidium* (guayaba), only identified in the pollen record. Remains of these plants have been reported since the Preceramic (Shady 2006; Bonavia et al. 2017) at Peruvian coastal sites. *Capsicum* grows on the coast, so people could have been gathering them from their cultivated fields. On the other hand, *Psidium* is usually found in regions with warmer weather (Brack 2003), so its access could, also, be a product of trading with inland valley communities.

Within the macrobotanical record, food plants were identified such as *Pouteria lucuma* (lucuma), *Inga feuilleei* (pacae) and *Persea americana* (avocado) (Ubillus 2014). Lucuma and pacae are Peruvian fruits commonly found on the coast revealing easy access to these resources for the local inhabitants. Avocado fruits and seeds, were recovered in high abundance; therefore, they were likely an important complementary addition to the Gramalote diet. Earliest appearance of these food plants date to Preceramic times in northern Peru (Dillehay and Piperno 2014). All of the food plants were important because they provided carbohydrates, minerals, and calories that enriched the strong marine-oriented diet. In addition, *Cucurbita* starch grains were identified (Villanueva 2014) and squash shells were recovered in a smaller quantity (Ubillus 2014), but their presence also supports agricultural activities at the Gramalote locality. Artifacts related to subsistence activities, such as simple digging sticks for gardening were reported (Prieto 2015). Due to the locality size, the coastal environment, the specific botanical evidence and the use of simple digging sticks, a small-scale agriculture is defined as a subsistence strategy for the Gramalote people.

Among reeds, macrobotanical remains (Ubillus 2014) and pollen grains of *Typha* and *Schoenoplectus* were identified suggesting the presence of water bodies in the area. Fragments of reed mats and baskets made of these two reeds were recovered from the Public Architectural Compound (Prieto 2015), indicating the utility of these plants as materials for construction, basketry, or for industrial purposes in general. More than 80 textiles made using these reeds were recovered, the most common being woven textiles and cordage (Prieto 2015). The presence of wild plants also supports the availability of water in the surrounding area. Grasses are abundant as are insect-pollinated species from the Asteraceae and Fabaceae families which are potentially indicative of cultural use (Bohrer 1981).

Some trees that are considered as wood sources were identified in the pollen record. *Schinus molle* and *Prosopis* are commonly found on the coast, their wood is used as fuel, and they are also planted along the borders of agricultural fields to shade crops. These resources were available in the Gramalote area as their range of distribution in Peru includes the northern coast (Brako and Zarucchi 1993). Hansen et al. (1994) provides information on late Quaternary vegetation change in the central Peruvian Andes where pollen evidence of *Alnus* dates as early as 9410 BCE. Therefore, the distribution of *Alnus* has been noted on the Andean western slope since prehistoric times reaching altitudes of 3500 m.a.s.l. (Brako and Zarucchi 1993). I suspect that these people could have obtained the wood by interacting with other groups in Andean valleys or going to gather it from far distances up slope from the site.

Another important plant which was potentially used as fuel is *Tillandsia*. Today, it grows on the slopes of Cerro Campana, 12 km. northeast of Gramalote, from which people may have obtained this resource. Evidence supporting its use as fuel is documented by the many carbonized fragments of bromeliads that have been recovered from several hearths (Prieto 2015) making *Tillandsia* the most common plant at Gramalote during the Initial Period. *Lagenaria siceraria* (gourd) is considered an industrial plant because its fruit, after a drying process, is usually shaped and carved to serve as containers. Many of these gourd shells have been recovered during excavations at the site (Ubillus 2014). There is evidence of its early cultivation in the north Coast of Peru since at least 8050 BCE. (Rossen 2011); however, by the Late Preceramic it was widely spread in and grown in the Andean region (Whitaker 1983).

In general, all the identified taxa suggest that the presence of local marshlands, where reeds are predominant, and the valley environments allowed for the growth of crops in the area surrounding the Gramalote site. The archaeological evidence suggests that the fishing community cultivated plants in their local territories but also gathered or traded some with other Initial Period societies. People used plant resources that grew on the coast and inland territories for different purposes, complementing their daily economic activities. The presence of three grinding stones and a batan (Prieto 2015) is evidence of cooking and/or medicinal technologies, so it appears that various plants were processed to be incorporated into the people's diet. An analysis of residues found on artifacts used at the site would help to assess these assumptions.

III.4.2 PHASE 3 (1300–1200 BCE)

In contrast to phase 2, pollen grains are less abundant in phase 3. However, edible plant sources, reeds, woody and wild plants are present.

Within food plants, pollen and starch (Villanueva 2014) grains of *Capsicum* and *Pouteria lucuma* are still present suggesting the continuous availability of lands that allowed agriculture in the Gramalote area. Additionally, the low pollen abundance and the presence of seven macrobotanical remains of *Zea mays*, and one dried root of *Pachyrhizus* (Ubillus 2014) continues to support the potential of an existing trading network with contemporaneous valley communities. According to the macrobotanical record, new plant taxa have been identified during this phase: *Phaseolus lunatus*, *Lycopersicon* and *Ipomoea batatas* (L.) Lam. (Ubillus 2014). All these taxa are cultivated on the northern Peruvian coast, providing edible resources such as seeds, fruits and roots that could be important ingredients of the daily menu. In addition, two batanes used as cooking technologies were recovered (Prieto 2015), which suggests that people processed food plants during the Initial Period. *Pouteria lucuma* is the most predominant food, followed by *Bunchosia armeniaca* (Cav.) DC. and *Persea americana* (Ubillus 2014). *Bunchosia armeniaca* could have been obtained from one of the river valley regions. It needs a less humid environment and warmer weather (Brack 2003) to grow; therefore, it could be obtained through trade with inland valley communities. Its presence in the macrobotanical record has been reported since the Preceramic in northern Peru (Dillehay and Piperno 2014).

The fossil pollen record still supports the presence of reeds, which implies the availability of water bodies in the Gramalote area. Asteraceae, Amaranthaceae, Fabaceae, Solanaceae, and Convolvulaceae pollen occur in greater abundance, whereas Poaceae pollen slightly decreased. The phytolith record also support their presence during phase 3 (Villanueva 2014). This group of wild and generally insect-pollinated plants provides information about the environmental surroundings and its cultural developments. Solanaceae and Convolvulaceae include species that are used as food such as *Lycopersicon* and *Ipomoea batatas* respectively. Taxa from the Asteraceae, Amaranthaceae, and Fabaceae families are often related to agriculture. Wild plants from the Asteraceae and Amaranthaceae family can also be indicators of cultural disturbance resulting from agriculture (Hansen et al. 1994). Species of the Fabaceae family would be important because they often contain symbiotic bacteria within their nodules that increase the nitrogen and soil fertility necessary to maintain the ecological stability of the soil environment (Glyan'ko 2015). Within reeds, the taxa identified in phase 2 are also present in phase 3. However, *Gynerium sagittatum* (Aubl.) P.Beauv. and *Schoenoplectus* are the predominant reeds during phase 3 (Ubillus 2014), whereas *Furcraea* appeared for the first time in the macrobotanical record as evidenced by a sedge rope (Prieto 2015).

Gourd is still representative in the macrobotanical record, but cotton remains are also abundant (Ubillus 2014). A wooden weaving tool and a fragment of a wooden spatula have been recovered (Prieto 2015), suggesting that this activity was part of Gramalote household industries. Pieces of cotton cordage and fragments of small size mesh nets were also recovered in this archaeological context (Prieto 2015), supporting the use of cotton for industrial purposes. Fragments of pollen grains were identified in the fossil record from the Malvaceae family to which cotton belongs; however, it cannot be certain that they are from cotton. In this case, 122 macrobotanical remains (Ubillus 2014) provide a more specific level of identification in comparison to the microanalysis which is affected by several types of degradation processes including those from biological, chemical or mechanical agents (Bryant et al. 1994). The number of *Tillandsia* remains increased and it continued to be the most abundant plant in the macrobotanical record based on the number of carbonized fragments of these plants found in and around hearths (Ubillus 2014).

The analysis of botanical remains suggest the presence of arable land and water bodies in a river valley environment in the Gramalote surroundings during phase 3. The archaeological record suggests that phase 3 represents Gramalote at a moment of gradual abandonment (Prieto

2015). The pollen abundance of reeds, food plants and wood sources decreased, whereas wild plants were found with greater pollen abundance supporting the idea of abandonment. Plants were still used but apparently with less intensification than seen in phase 2. In addition, the presence of inland areas with higher altitudes and less humid environments where other plants could be cultivated is suggested to be within walking distance from Gramalote. The accessibility to new environments and habitats allowed the cultivation of diverse plant resources, intensifying people-plant relationships and potentially motivating territorial expansions or conquests of later Ceramic cultures. A systematic shift of the major coastal centers of activity to inland locations, particularly the rich valley lands nearby and away from the ocean front, is observed within the Initial Period societies (Burger 1992), facilitating the development of social and political complexity seen in later Ceramic cultures.

III.4.3 SURFACE SAMPLES

I was concerned about the possibility of pollen downwash or downward vertical movement of modern pollen in the sampled areas (Horn et al. 1998); therefore, plants from the modern vegetation were identified in the actual pollen rain and by modern specimens collected in botanical surveys (Prieto 2015). The latter supports the pollen results confirming good sampling in the palynological methodology. *Acacia* and *Sonchus* are part of the modern vegetation in the Gramalote surroundings, and their pollen was not recovered in the past occupational phases. *Acacia* is a tree that grows on the coast of Peru, and it is a primary source of wood in wet environments. Local fishermen use *Acacia* wood as a mace club to kill fish while fishing offshore in their reed boats (Prieto 2015). On the other hand, *Sonchus* grows in different kinds of habitats such as roadsides, disturbed areas, gardens and cultivated lands. The possibility of contamination of modern pollen grains in the fossil record does not make it probable in this paleoethnobotanical analysis. The differences between modern and fossil pollen taxa, the well-developed and distinct stratigraphy (Prieto 2015), the absence of soil cracks (Godwin 1934) and the differential preservation (O'Rourke 1986) between modern and fossil pollen grains support an absence of pollen downwash between the strata. In addition, the use of multiple lines of evidence is important to differentiate among taphonomic processes that affect pollen grains (Pearsall 2015). In this case, the identified pollen taxa and the plants they represent are supported by the presence of evidence, such as starch and phytoliths (Villanueva 2014), from the same deposits as well as macrobotanical remains (Ubillus 2014; Prieto 2015) dismissing any probability of and vertical pollen movement. An identified industrial plant is *Sapindus saponaria* L. (Prieto 2015) which is used as soap for washing cloth or ceramic vessels, and as a poison for fishing activities in fresh water environments (Cogollo et al. 2008). Within food plants, fruit crops such as *Psidium* and *Pouteria lucuma* were identified and, as it was previously explained, they can easily grow on the Peruvian north coast, and in Gramalote they are observed around the site at the margins of two dry riverbeds. *Schoenoplectus* and *Typha* are the two taxa that represent reeds at the site. The presence of reeds is common in this part of northern Peru. In the case of Gramalote, *Schoenoplectus californicus* is cultivated in traditional rectangular sunken gardens close to the shoreline where a high water table provides an appropriate growing condition for this reed (Rondón et al. 2003). The fishermen population know the process of cultivating reeds, and this knowledge has been transmitted from generation to generation.

Gramalote is today surrounded by a modern town where human constructions have influenced and changed the environment. Wild plants, which are the most abundant, are found as invaders mainly of open and disturbed areas between the urban regions. Limited agriculture is practiced in the area and fishing is still an important economic activity for these coastal people. In addition, some plants are still growing in Cerro Campana because of its lomas or fog vegetation system.

III.5 Conclusion

According to the paleoethnobotanical record, people living in the Gramalote community during the Initial Period had a direct relationship with botanical resources available in their surroundings. The pollen record supported by the presence of macro and microbotanical remains, including remains of materials made from plants and agricultural tools, suggests that botanical resources played a role in subsistence during the Initial Period of Gramalote. Staple foods rich in carbohydrate content complemented the Gramalote diet rich in marine proteins. Also, the community had access to woody plants for construction or fuel uses as reflected in the archaeological record of the site. Different species of reeds were available in the wet environments surrounding Gramalote area. The reeds were cultivated and used as materials for construction and to create mats, baskets, and textiles.

Gramalote inhabitants took advantage of the marine resources that the Pacific Ocean provided, but also used plants as a part of their daily subsistence activities. An environment with the presence of water bodies and arable land from a river valley system promoted the availability of plant resources in Gramalote. In addition, people interacted with plants gathered from other river valley habitats, or traded with contemporary communities located in territories where ecological and environmental conditions allowed the cultivation of diverse useful plants. The accessibility to inland territories resulted in adaptations to new environments and habitats where later complex Ceramic cultures settled down. The study of botanical proxies from the Gramalote community helps to understand the strategies that people developed to subsist during the Initial Period, and supports the idea that the confluence of economies based on marine and plant resources contributed to the emergence of political and social complexity among Andean civilizations in northern Peru.

III. 6 References

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CHAPTER IV

ETHNOARCHAEOLOGY TO UNDERSTAND THE PLANT TEK OF THE FISHING COMMUNITY OF HUANCHACO*

IV. 1 Introduction

This dissertation research was conducted following an ethnoarchaeological approach to study plant uses through time in northern Peru. In chapter II the modern uses of plants by members of the fishing community of Huanchaco were analyzed and in chapter III the paleoethnobotanical record of the Gramalote site was reconstructed. In this chapter, results from chapters II and III are combined to facilitate the study of people-plant relationships within the coastal culture across time. In addition to the analysis of ethnographic and archaeological evidence, historical evidence from the colonial period was studied as during that time major social changes occurred in Peru that affected the local flora richness and abundance in the north coast.

Ethnoarchaeology has contributed to archaeological theory building for over a century. It has been practiced by researchers from different theoretical frameworks such as processual (Ascher 1962; Brain 1967; Gould 1968; Heider 1967; White 1968) and postprocessual (David et al. 1988; Hodder 1982; 1991; Fewster 2006) addressing the study of diverse types of societies around the world (David and Kramer 2001). Ethnoarchaeology is defined by middle range theory which focuses on material correlates for archaeological interpretation (Binford 1978; Watson 1979; Wright 1977; Yellen 1977; Gould 1980). In South America, the first ethnoarchaeological

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*The case study presented in section IV.4 was reprinted with permission from "Dynamism in Traditional Ecological Knowledge: Persistence and Change in the Use of Totora (*Schoenoplectus californicus*) for Subsistence in Huanchaco, Peru" by Rossana Paredes and Allison L. Hopkins, 2018. *Ethnobiology Letters* 9(2):169-179.

studies were conducted during the 1970s and 1980s in the Amazon and Andean regions (Lyon 1970; DeBoer 1974; Zeidler 1984; Horn 1984; Miller 1977; Wüst 1975). Thereafter, research questions became more complex and varied (for an up-to-date discussion of the ethnoarchaeology in South America see Politis 2015, 2016). Ethnoarchaeological methods, drawn from ethnography and archaeology, to carry out historically situated and ethically based research on how people engage with the material, solve material problems and interact with the materiality of other living entities (Lyons and Casey 2016). In a general theoretical frame, this ethnoarchaeological investigation relates the modern use of plants to human behavior expressed as plant TEK, via middle-range research, to the paleoethnobotanical record emphasizing not only the explanations for the archaeological record but the cultural dynamism responsible for that record (Binford 1977, 1978, 1980, 1981; Wiessner 1982; Raab and Goodyear 1984). The analysis of the modern and fossil plant record is used to understand the role of botanical resources across time in the subsistence practices of a coastal community where fishing is a major economic activity.

Ethnoarchaeological research expands the range of plant use categories frequently identified in the paleoethnobotanical record. Remains of plants used as food or as materials for construction and crafting are usually recovered from archaeological sites, but remains of medicinal plants are not commonly identified in the fossil record. The reason may be related to preservation issues or the lack of a modern collection reference. Medicinal plants can be studied in modern cultures. The collection and identification of botanical specimens and ethnographic data on modern medicinal plant uses help to culturally and scientifically identify fossil remains. Researchers would look for botanical taxa in the archaeological record that have been identified with a medicinal use in the modern record. As observed in the analysis of pollen content of 32 coprolites from Caldwell Cave, Texas, past and present analyses of coprolite samples indicate that medicinal plants such as

Ephedra and *Larrea* were consumed possibly to help to cure chronic diarrhea (Sobolik and Gerick 1992).

Most archaeological cultures of Peru were originally defined on the basis of ceramic styles alone (Willey 1945). Although multi-proxy research to answer questions on settlement patterns, architecture and funerary practices are undertaken, ceramics remain as the primary source of information for reconstructing cultural sequences (Millaire 2009). This chapter emphasizes the importance of studying another type of evidence to assess ancient identities. In this case, the study of human knowledge and behavior in relation to the modern use of plants in the fishing community of Huanchaco is considered to explain, through analogy produced in an operational way, the archaeological observations on the roles of plants from the prehispanic occupations of the Gramalote site.

IV. 2 Ethnoarchaeological research in Peru

During the 1970s, ethnoarchaeological research started to be practiced in the Amazon region of Peru. Lyon (1970) studied the role of domesticated dogs in altering the archaeological record of mammal bones among the Wachipaeri of eastern Peru. Thereafter, DeBoer (1974) and DeBoer and Lathrap (1979) focused their ethnoarchaeological research on the longevity, making and breaking of pottery of the Shipibo-Conibo people. In the Andes, archaeological, ethnographic and historical research on material culture such as Andean technology was conducted to reconstruct Inca and early colonial history (Morris 1978; Morris and Thompson 1985; Lechtman and Soldi 1981; Matos 1994; Urton 2003, Ramón 2008). Most ethnoarchaeological research has been carried out in those two regions of Peru while the coast region is less developed within this scientific field. See Sillar and Ramón 2016 for a detailed reference. Glass-Coffin, Sharon and

Uceda (2004) presented an ethnographic compilation on the work of contemporary female healers to interpret their role in the Moche period and their representation on the ceramics recovered from the archaeological complex of the Huaca del Sol and the Huaca de la Luna in northern Peru. The ethnoarchaeological study on *chicha* production by Hayashida (2008) on Peru's north coast provided information on the production steps, the labor and raw material inputs, and the variation in technology and organization associated with cultural differences. Klaus et al. (2009) used ecological, ethnohistoric and ethnoarchaeological evidence to associate degenerative joint disease in human remains with a mechanically strenuous lifestyle among the indigenous Moche population in the Lambayeque region of the northern coast of Peru.

This dissertation research is a pioneering contribution on the study of plant uses in a fishing community in the coastal region of Peru where ethnoarchaeological evidence improves our ability to identify similarities and differences between the past and present people-plant relationships.

IV. 3 TEK on plant uses through time

The ethnoarchaeological study of the fishing community of Huanchaco indicates persistence and change in TEK of plant uses through time. Table 4 presents the identified botanical taxa from the prehispanic, colonial and modern record of Huanchaco. These taxa come exclusively from the findings in chapter II and III and their presence during the colonial period is confirmed by the analysis of ethnographic data (Gillin 1947; Kautz and Keatinge 1977; Klaus 2016; Prieto 2009; Ramírez 1996). Although most of the botanical taxa have been identified in only one or two types of record (Table 4), the TEK of seven useful plants seems to have been practiced for some 5000 years in this northern region of Peru. Archaeological evidence for the use of these plants has been recovered from Archaic sites and it is clear that an already developed plant TEK existed for the Initial Period. As discussed in chapters II and III, evidence from later cultures, such as Moche and Chimu, and the colonial period, also supports a continuity in the use of these botanical resources. Today, people in Huanchaco still use these plants demonstrating the adaptive capacity of TEK in response to social change. Over time, diverse botanical resources used for food, medicinal and industrial purposes have played an important role in the development of subsistence strategies in Huanchaco. The next section presents a discussion on the role of the useful plants which presence have been recorded in the paleoethnobotanical, colonial and modern record emphasizing the continued use of these plants in the community. Some botanical specimens have been used for the same purpose since prehispanic times, while the use of other specimens have changed.

The results on this chapter emphasize the economic and cultural importance of plants as part of the Huanchaco's cultural heritage. Fishermen and their families are aware of the constant loss of plant TEK in their community; however, they struggle to maintain it by unconditionally sharing their traditional knowledge with younger generations and in every daily activity. This particular plant TEK identifies the local people of Huanchaco as members of the powerful and well-recognized Moche culture that settled in the Peruvian north coast between 200 to 850 CE. This is a clear example of how the "cultural-survival" aspects of ancient Peruvians contribute to define the cultural identity of a modern group of people and the multicultural awareness of the entire Peruvian culture.

IV.3.1 Food plants

The consumption of edible plants rich in carbohydrates, minerals and calories is a fundamental component of the subsistence strategies of the fishing community as it complements and enriches their strong marine-oriented diet. The archaeological record suggests that people have had access to food plants, such as *Pouteria lucuma*, *Psidium guajava* and *Zea mays*, since the Preceramic. Macro and microbotanical remains of these edible resources have been recovered from Archaic sites in northern Peru (Bonavia et al. 2017; Grobman et al. 2012; Haas et al. 2013; Shady 2006) being the TEK on their use preserved for many generations.

Pouteria lucuma, locally known as lucuma, is a 6 – 15 m tall tree with edible fruits that are mostly used in the preparation of juices and desserts. This tree has been cultivated in Peru since prehispanic times across Coastal, Andean and Amazonian regions (Brack 1999). Its fruits are represented in the pottery and textiles of the Moche people (Fernandez and Rodriguez 2007) and was part of the colonial flora (Gillin 1947) supporting a continuity in the use of lucuma in later societies. *Psidium guajava* is a native tree, 3 – 10 m tall, with high vitamin C content fruits that were also part of the prehispanic diet (Brack 1999). The pollen record of Gramalote shows that guajava was present during the Initial Period in Huanchaco and, despite the Spanish efforts to control and transform the indigenous culture (Ramírez 1996), it continued being cultivated during colonial times (Prieto 2009). Today, fruits can be collected from the few lucuma and guajava trees that grow in the river valley habitats. The people, however, prefer to buy the fruits at the local market.

Zea mays, on the other hand, was probably not of local origin in the distant past. It was product of trading with other Initial Period societies settled in inland sites where the soil and weather conditions were adequate for its cultivation (Paredes 2018). The construction of irrigation systems by the Chimu and the Inca modified the way of life in Huanchaco. People started to participate in agricultural activities (Prieto 2009) and maize became a local crop (Kautz and Keatinge 1977). Today, maize is sparsely cultivated in the agricultural fields near Huanchaco. This

Table 4 List of botanical taxa identified in the Prehispanic record (paleoethnobotanical identification from Chapter III), Colonial record (ethnographic reference from Gillin 1947; Kautz and Keatinge 1977; Klaus 2016; Prieto 2009; Ramírez 1996), and the Modern record (ethnobotanical identification from Chapter II).

Family	Scientific Name	Local name	Traditional Use	Prehispanic Record	Colonial Record	Modern Record
Amaranthaceae	*Alternanthera halimifolia*	Flor blanca	Medicine	x	x	x
Anacardiaceae	*Schinus molle*	Molle	Industrial	x	x	
Asteraceae	*Ambrosia* sp.	Artemisa	Wild	x		
Asteraceae	*Baccharis salicina*	Chilco	Medicine		x	x
Asteraceae	*Bidens pilosa*	Cadillo	Medicine			x
Asteraceae	*Encelia canescens*	Camporco	Medicine			x
Asteraceae	*Mutisia* sp.	Bejuco	Wild	x		
Asteraceae	*Sonchus oleraceus*	Cerraja	Medicine		x	x
Asteraceae	*Taraxacum* sp.	Diente de leon	Wild	x		
Asteraceae	*Trixis* sp.	Lingo lingo	Wild	x		
Betulaceae	*Alnus acuminata*	Aliso	Industrial	x		
Bignoniaceae	*Jacaranda acutifolia*	Arabisca	Medicine			x
Boraginaceae	*Tiquilia dichotoma*	Flor de arena macho	Medicine			x
Boraginaceae	*Tiquilia paronychioides*	Flor de arena hembra	Medicine			x
Bromeliaceae	*Tillandsia* sp.	Achupalla	Industrial	x		
Cannaceae	*Canna indica*	Achira	Ornamental			x
Convolvulaceae	*Ipomoea batatas*	Camote	Food		x	x
Cucurbitaceae	*Cucurbita maxima*	Zapallo	Food		x	x
Cucurbitaceae	*Lagenaria siceraria*	Checo	Industrial		x	x

Table 4 Continued

Family	Scientific Name	Local name	Traditional Use	Prehispanic Record	Colonial Record	Modern Record
Cucurbitaceae	*Luffa operculata*	Jaboncillo	Industrial			x
Cyperaceae	*Schoenoplectus californicus*	Totora	Industrial	x	x	x
Euphorbiaceae	*Acalypha* sp.	Acalifa	Wild	x		
Fabaceae	*Acacia macracantha*	Faique	Industrial	x	x	x
Fabaceae	*Cajanus cajan*	Frejol de palo	Food		x	x
Fabaceae	*Lablab purpureus*	Lenteja bocona	Food		x	x
Fabaceae	*Medicago sativa*	Alfalfa	Medicine		x	x
Fabaceae	*Pachyrhizus* sp.	Ajipa	Food	x		
Fabaceae	*Phaseolus*	Frijol	Food	x	x	
Fabaceae	*Prosopis pallida*	Algarrobo	Industrial	x	x	x
Fabaceae	*Mimosa albida*	Tapa tapa	Medicine			x
Lamiaceae	*Mentha spicata*	Hierba buena	Food		x	x
Lauraceae	*Persea americana*	Palta	Food		x	x
Malvaceae	*Gossypium barbadense*	Algodón pardo	Medicine	x	x	x
Malvaceae	*Urocarpidium* sp.	Malva	Wild	x		
Myrtaceae	*Psidium guajava*	Guayaba	Food	x	x	x
Passifloraceae	*Passiflora edulis*	Maracuya	Food		x	x
Poaceae	*Distichlis spicata*	Grama salada	Wild			x
Poaceae	*Zea mays*	Maiz	Food	x	x	x
Polygonaceae	*Antigonon leptopus*	Enredadera	Wild			x
Polygalaceae	*Monnina* sp.	Clarin chico	Wild	x		
Sapindaceae	*Sapindus saponaria*	Choloque	Industrial		x	x
Sapotaceae	*Pouteria lucuma*	Lucuma	Food	x	x	x
Solanaceae	*Capsicum* sp.	Aji	Food	x	x	

Table 4 Continued

Family	Scientific Name	Local name	Traditional Use	Prehispanic Record	Colonial Record	Modern Record
Solanaceae	*Cestrum auriculatum*	Hierba santa	Medicine			x
Solanaceae	*Physalis* sp.	Aguaymanto	Food	x		
Solanaceae	*Solanum* sp.	Tomatillo silvestre	Food		x	x
Typhaceae	*Typha* sp.	Enea	Industrial	x	x	

suggests that the subsistence strategies related to cultivation became more complex through time since the Initial Period to the present, it was facilitated by technological innovation and ecological changes.

TEK on maize consumption is also related to *chicha*, maize beer (Figure 9). *Chicha* has been produced and consumed in the north coast of Peru since the prehispanic period (Hayashida 2008; Prieto 2004; Shimada 1994). It affords a source of refreshment and nutrition, and is an important element in social, political, and ritual exchanges (Hayashida 2008). In Gramalote, a spoon-like artifact made of gourd was recovered, it resembled a serving scoop still used today to serve *chicha.* However, there is yet no evidence of *chicha* perse at the site (Prieto 2015). During colonial times, the use of maize was also associated with ritual events; coastal peoples made offerings of powdered white maize and red pigment to show respect to the ocean (Murua 1962). In the recent past, *chicha* was served every time sea lion meat was prepared in a household (Anhuamán 2008). Events related to toasts and informal meetings where food was shared inside a domestic unit were popular among traditional families in the La Libertad region (Gillin 1947; Anhuamán 2008). Before meetings started, a gourd bowl, usually filled with *chicha,* was passed among the participants to share a drink (Jimenez-Borja 1938). In Huanchaco, this event was known as *causeo* where large quantities of maize beer were imbibed in a single large and open bowl called *lapa* and the main food consisted of dried fish with manioc and sweet potato (Prieto 2015). Today, the easy access to commercial beer has replaced the preparation of traditional maize beer and it seems likely that the TEK about *chicha* will be lost. Only one woman in the fishing community continues to prepare *chicha*. She claims that community members like to consume but not prepare it and that young people are no longer interested in preserving that TEK.

Figure 9 Maize *chicha* in a gourd bowl prepared by a local woman in Huanchaco

IV.3.2 Industrial plants

Acacia macracantha and *Prosopis pallida*, as noted in chapter II, are woody plants used by inhabitants of ancient Gramalote and the modern fishing community of Huanchaco for industrial purposes. In addition, the ethnoarchaeological record shows that *Schoenoplectus californicus*, totora reeds, and *Gossypium barbadense*, cotton, have been used in benefit of the coastal people's subsistence.

Acacia macracantha, commonly called faique, is a 5 – 6 m tall tree with long spines and small yellow inflorescences that grow along the Peruvian coast in river valley habitats. People use its wood for construction and fuel purposes (Fernandez and Rodriguez 2007). Although pollen grains were not identified in the fossil pollen record (Paredes 2018), stem pieces and one weaving artifact made from faique timber were recovered from Initial Period sites in Gramalote (Prieto 2015). The presence of *Acacia macracantha* in Archaic sites (Dillehay 2017) suggests its early traditional use in northern Peru. Today, faique grows in wild spots within the agricultural fields and people take advantage of their stems with long spines to protect their properties from invaders. TEK on the use of faique wood also emphasizes its durability in wet environments. Fishermen use the wood to make mace clubs to kill fish while fishing, paddles, oars and other fishing gear (Prieto 2015). *Prosopis pallida*, locally known as algarrobo, is a native tree of the northern coast of Peru that grows in arid and semiarid zones. It fruit is used to prepare syrup and to feed livestock, and its wood is used as fuel and for construction (Fernandez and Rodriguez 2007). The analysis of macrobotanical remains indicates that algarrobo wood was used by ancient Peruvians in La Libertad region for the construction of houses, tombs, sanctuaries and as fuel for cooking (Rodriguez et al. 1996). *Prosopis pallida* pollen was found at the Gramalote site indicating that the tree grew in the area during the Initial Period. After the Spanish conquest, large agricultural fields in northern Peru were replaced by sugarcane plantations (Ramírez 1996) and some *Prosopis* specimens were felled during this process. However, the promulgation of colonial ordinances prohibited the consumption of guinea pigs, dogs and products derived from *Prosopis* (Figueroa and Idrogo 2004), which benefited the presence and abundance of the tree in the area. Today, *Prosopis pallida* serves as windbreakers and fences that divide the agricultural fields and shade crops in Huanchaco. Along the Peruvian coast, the abundance of algarrobo specimens has been decreasing over the last years as its wood has been utilized with great demand as cooking fuel in rotisserie restaurants (Depenthal and Meitzner 2018).

Schoenoplectus californicus, totora, is a native reed that grows in humid regions in the coast of Peru (Figure 10). In Huanchaco, its rhizomes are planted in sunken gardens close to the beach and can grow up to 4 m tall (Rodriguez et al. 1996). Its identification in the pollen record suggests the presence of water bodies in the Gramalote area during the Initial Period and the recovery of macrobotanical remains supports the use of these reeds for the construction of sea vessels since prehispanic times. After the Spanish conquest, bigger totora boats were constructed for ceremonial purposes (Prieto 2016). As a product of Catholic influence, a *patacho*, a large totora vessel, was constructed during the Spanish conquest to transport the sacred image of Nuestra Señora de la Candelaria from the anchored brig to the shore, which is the actual religion icon of the Huanchaco people (Prieto 2011). Today, totora is the most important plant in Huanchaco and in the next major sector of this chapter a case study on its TEK is presented.

Gossypium barbadense, commonly known as *cotton*, is native of the Peruvian arid coastal desert that grows in undisturbed areas. Its fiber, with a great diversity in colors, has been used by many prehispanic cultures. Dark fibers of cotton were selected by ancient fishermen in northern Peru to create fishing nets (Bird et al. 1985). The study of abundant archaeological remains proposes that *cotton* was cultivated during the Late Archaic (Stephens 1975; Shady 2006, Sandweiss 2009) and suggests open and easy access in Gramalote. Cords, fishing nets and fiber fabrics manufactured with brown, white and beige cotton fibers were recovered from the two Initial Period occupations (Prieto 2015). Also, the presence of cotton balls, leaves and stems supports its cultivation in Gramalote and its surroundings. Cotton continued to be used for industrial construction in later coastal communities. During the colonial period, indigenous people cultivated and weaved cotton to exchange for gifts or payments from the *Curaca*, the regional governor, under the Spanish imposition (Ramírez 1996). In the present, the use of the cotton is medicinal-related in Huanchaco. People collect the fiber from the wild specimens that grow within the agricultural fields and use it to treat *susto.* Apart from scattered fibers of cotton found in the site, there is no clear evidence that supports this medicinal use during prehispanic times.

IV.3.3 Medicinal plants

Pollen grains of *Alternanthera halimifolia*, commonly known as flor blanca, were recovered from the Gramalote site. Although its medicinal use is not evidenced from prehispanic times, it was present in the ancient fishing village. Flor blanca is an herb (Figure 11) that grows in wild conditions in disturbed areas, lomas, riversides and rocky slopes (Tropicos 2018). In Huanchaco, its flowers are collected from spots of wild plants in the river valley habitats to prepare medicinal beverages that help women reduce inflammation after giving birth. In this and the cotton case, the ethnobotanical record shows a medicinal use that may be practiced in the past but that was not recorded. Archaeologists working in the north coast of Peru can now be more cautious and look for paleoethnobotanical evidence that suggest the presence and use of these two plants for medicinal purposes, expanding the number of taxa in the medicinal record.

Figure 10 After a drying process, high quality totora reeds are selected for the construction of sea vessels.

Figure 11 *Alternanthera halimifolia* growing in wild conditions in Huanchaco

As noted earlier, the use of seven botanical resources supports a continuity of TEK since prehispanic times to the present. Nonetheless, it is clear that plant uses have also changed as a response to social change. The use of local food, medicinal and industrial plants has decreased with the access to commercial products that globalization processes brought into town. People prefer today to buy these products instead of cultivating, collecting or processing botanical resources. A limited number of studies on TEK have assessed the ability of these knowledge systems to cope with social and environmental change (Athayde et al. 2017; Reyes-García et al. 2014). Historically, ethnobotanical studies have focused on how to capture the loss of TEK that was often assumed to result from globalization processes (Hanazaki et al. 2013). Gómez-Baggethun and Reyes-García (2013), however, argue that this perspective is shortsighted and that TEK should be studied as dynamic systems of knowledge that are able to cope with some degree of social change.

In Peru, globalization has produced "hybrid cultures" (Burgos et al. 2003) resulting from the interaction of people from different cultures and with different identities. Hybrid cultures are characterized as maintaining some aspects of local traditions and knowledge while incorporating new practices. The neo-liberal economic reforms in Peru during the late 1980s through the 1990s accelerated this process through promoting trade liberalization that favors exchange between local and foreign markets (Crabtree 2002). The dynamic quality of TEK in northern Peru is evidenced by healers and the public who react to increasing access to a global market by experimenting with newly available remedies while maintaining their healing traditions (Bussmann 2013). Studies of the dynamic quality of TEK have primarily been carried out in Amazonian and Andean communities (Balslev et al. 2010; Paniagua-Zambrana et al. 2017; Pirker et al. 2012). However, the fishing community of Huanchaco has shown that they are able to adapt their TEK to changing socioeconomic conditions.

IV. 4 Case study: Persistence and change in the use of totora (*Schoenoplectus californicus*) for subsistence

The ethnoarchaeological approach of this dissertation allowed me to study dynamism in totora TEK which is discussed in this case study. The dynamic quality of TEK as a response to change is clearly identified by the persistence and change in the use of totora across time. The analysis of archaeological, historical and ethnographic evidence indicates that members of the fishing community have been able to create, discard and replace totora uses as an adaptive response to change benefiting their subsistence since Prehispanic times. Ethnographic data on the modern uses of totora and a discussion on the dynamic quality of its TEK are presented in the next sections of this case study.

The technological revolution has influenced the fishermen's traditions by motivating them to develop and adopt new fishing techniques and vessels through time. The large-scale fleet (with a hold capacity of more than 32.4 m^3 per vessel) now dominates the fishing industry off the coast of Peru and is composed mainly of industrial pelagic purse seiners and coastal trawlers (FAO-UN 2010). These large boats have allowed fishermen to extract a variety of marine resources in much greater quantities in comparison to small and artisanal boats. However, these processes of delocalization (Pelto 1973) in the construction and use of specialized fishing vessels have not been adopted by fishermen in Huanchaco. People have developed economic systems where different types of boats, from traditional vessels to those constructed using the latest technology, are used in combination to increase the efficiency and productivity of fisheries.

The fishing community of Huanchaco uses totora reeds for three different economic purposes: the construction of caballitos de totora fishing boats, souvenirs, and mats. There is a clear gender division of labor in the growing and processing of totora for the production of these three different goods. Men oversee the cultivation and harvest of totora, the construction of caballitos, and the creation of souvenirs, while women weave totora mats. The reason for this gender differentiation, according to the fishermen, is that women are not strong enough to cut, clean, and carry large amounts of reeds to construct the heavy and long caballitos de totora. Women know where the sunken gardens are located but it is rare to see a woman around the protected reserve, especially taking care of the reeds that belong to their families. If women need totora reeds for the construction of mats or other activities, then they ask their spouses or male relatives for some or buy them at the local market. None of the participants have ever seen a woman making her own caballito; however, women sometimes assist with the process through acquiring construction supplies such as ropes and buoyant materials in the market. Additionally, men have not been observed weaving mats.

IV.4.1 Totora Reed Vessels

The caballitos de totora are used as vessels for fishing in the Pacific Ocean. The construction process takes at least two hours with two men working together and is divided into three stages. The fishermen take their time in constructing the vessel because they believe that the quality of the vessel can have a direct impact on their fishing performance. First, they separate the totora reeds into four bundles, two made of first-class reeds, 3 m long, and the other two of the second-class reeds, 2 m long. After this, they place a square piece of Styrofoam in each bundle and tie them with a nylon rope, generating two longer "mother" bundles and two shorter "son" bundles. Next, each son bundle is connected to each mother bundle by tightly wrapping each mother bundle in a spiral fashion (one clockwise and the other counter clockwise) with a nylon rope, which forms a pit where the son bundle is placed (Figure 12a). Finally, the two mother-son bundles are joined with a double twist nylon rope, making several knots along the caballito length and creating an upturned bow (Figure 12b). The caballito is then ready to sail (Figure 12c). The reed vessel lasts for approximately a month and then a new one needs to be fashioned.

IV.4.2 Totora Souvenirs

Elderly men and retired fishermen make souvenirs that they sell to the great number of tourists that visit Huanchaco each year. Artisans buy totora reeds and make different kinds of souvenirs such as earrings, key chains, refrigerator magnets, photo frames, and other ornaments that they sell in the artisan market. The most popular souvenir is a little version of the caballito, an ornament that can be used for decoration in a home or office (Figure 13). The construction process is a faster and simpler version of the process for making the full size caballitos. Four bundles of short totora reeds, two mothers of 15–20 cm long reeds and two sons of 5 cm long reeds, are needed to make a little caballito. The bundles are connected in the same fashion as the full size caballito de totora (Figure 13a). Once each son bundle is placed inside each mother bundle, the artisans finely sharpen the reeds on the end using a razor to get the upturned bow like the full-sized version. Then, each piece is tightly wrapped in a spiral fashion in both clockwise and counter-clockwise directions to reinforce the caballito shape. Finally, both bundles are connected using a fine blue or black nylon rope by making knots every centimeter (Figure 13b). The artisans write on a little piece of totora "Huanchaco – Trujillo – Peru" and attach it under the nylon strips (Figure 13c). It takes about 15 minutes for each artisan to make a caballito souvenir. The artisans charge between 5 and 50 soles (between 2 and 16 US dollars) for their products depending on the type and size.

IV.4.3 Totora as Mats

Totora is the raw material in the weaving of mats, which are then crafted into handheld fans, artisanal mattresses, and material for house construction, especially roofs. Currently, there is just one woman that makes and sells mats in the town. She is now over 60 years old and she has been making mats since she was young. Therefore, her name is well known around the town, and everyone that needs a high quality and well-crafted mat goes to see her. She buys the totora reeds and shapes them according to her clients' preferences. Then, she starts twining the totora reeds by

Figure 12 Fishermen constructing a caballito de totora. 12a: Son bundle is connected to mother bundle. 12b: The two mother-son bundles are joined with a nylon rope. 12c: The caballito is ready to sail. Reprinted with permission from Paredes and Hopkins 2018.

Figure 13 Artisans creating a caballito souvenir. 13a: Reed bundles are connected in the same fashion as the full size caballito. 13b: Bundles are finely sharped, tightly wrapped and connected using a nylon rope. 13c: A “Huanchaco-Trujillo-Peru” label is attached under the nylon strips. Reprinted with permission from Paredes and Hopkins 2018.

Figure 14 A local woman weaving a mat. Reprinted with permission from Paredes and Hopkins 2018.

interweaving a cotton cord at intervals of 30 cm until the desired length is reached (Figure 14). It takes all day for her to finish one small mattress (twin size). Her perception is that this is a long time and is due to her advanced age. She can take up to five days to create a mat, depending on the purpose, the size of the mat, and the number of orders she receives. She charges an average of 30 soles (less than ten US dollars) for a 3 m x 4 m mat.

IV.4.4 Discussion

The dynamic quality of TEK in response to economic and technological changes (Gómez-Baggethun and Reyes-García 2013) is evidenced by the fishing community of Huanchaco. TEK related to totora use for subsistence has persisted and changed in response to the growing tourism industry, the reduction in availability of reeds, and the increasing accessibility of industrially produced materials that can be used in boat and house construction. Totora continues to play an important role in economic strategies that support the subsistence of the fishing community in Huanchaco. Fishing community members have a direct relationship with totora reeds, understanding and processing the plant in different ways according to their gender roles.

TEK related to totora uses has persisted through time despite the changes that have taken place as the result of colonization and globalization. Population growth and government prioritization of tourist activities have reduced the availability of arable land; however, the remaining fishermen have claimed an area exclusively for totora cultivation. Also, colonization introduced the use of western sea craft but the local people developed a fishing system where different types of sea craft, industrial and artisanal, can be used (Prieto 2016). The ethnoarchaeological record provides evidence of continuity in aspects of the construction and use of caballitos de totora since pre-Hispanic times. Caballitos de totora were considered the principal means of water transportation for coastal people before the Spanish Conquest (Lothrop 1932). The pottery from the Chavin, Moche, and Chimu cultures portray daily activities of people and gods and includes the use of caballitos de totora for transit as well as for fishing within several coastal sites (Baessler 1906; Benson 2012; Rostworowski 1981). Larger caballito*s* represented in the Moche iconography of San Jose de Moro are occupied by a female figure, the Priestess, and male figures with supernatural attributes (Castillo 2003; McClelland et al. 2007). In addition, the paleoethnobotanical record of the Gramalote site suggests the presence and perhaps cultivation of totora in the Huanchaco surroundings. Among these totora remains recovered are a 10-cm fragment of a small caballito de totora end showing totora reeds tied with a cotton rope (Prieto 2015); pollen grains identified in sediment samples from two human occupations (Paredes 2018); phytoliths identified from sediment samples and artifacts recovered from three human occupations (Villanueva 2014); and fragments of cords, baskets, and mats made of totora and remains of the reed itself recovered during the last period of field excavations of the site (Prieto 2015).

Coastal peoples can cultivate and use totora in their daily activities, especially as a means of transportation that allows fishermen to interact with the resource-rich sea. The use of totora vessels in Peru is favored by the coastal relief with numerous shallow coves that are not appropriate for anchoring large and heavy boats (Prieto 2016). Currently, totora reeds are used exclusively in seven fishing communities in northern Peru: Uripe, Huanchaco, Puemape, Cherrepe, Puerto Eten, Santa Rosa, and Pimentel, which are located within the La Libertad and Lambayeque regions (Prieto 2016). In the recent past, totora vessels were also used in coves along the central and southern Peruvian coast, particularly along the Chincha, Cañete, Asia, Mala, Chilca, Lurin, and Chillon valleys (Edwards 1965; Ortiz 1990; Rostworowski 2004); however, people from those regions have replaced totora reed craft with boats constructed from more durable materials.

The TEK related to caballitos is considered an important part of the Huanchaco cultural heritage and, in an effort to maintain it, children start interacting with reeds in the early years at school. They learn how to make small replicas of caballitos de totora as an art project. In addition, parents teach their children to sail using reed vessels, and when they become adolescents they start learning the construction process of the full sized caballito. Rondón and colleagues (2003) have described in detail the process involved in the caballito construction and the observations presented in this study indicate that the construction process has not changed in the intervening years. As a result, TEK related to totora use in Huanchaco continues to be transmitted from older to younger generations through observation as an embedded part of culture, much like McMillen and colleagues (2017) found in Hawai'i for knowledge storage and transmission on subsistence livelihood practices.

On the other hand, TEK on totora use has changed in response to new economic and technological conditions, highlighting the dynamic aspect of TEK. Although cultivation areas are limited, thus reducing the supply of totora, fishermen have not stopped constructing caballitos; instead they have replaced the reeds used as filling with Styrofoam. The result is a more durable and buoyant caballito. In addition, nylon ropes have replaced the cabuya (*Furcraea andina* Trel.) ropes that fishermen previously used to tie the bundles of totora (Rondón et al. 2003). The main reasons for that change is that nylon ropes are cheaper and more readily available than cabuya ropes. Today, no cabuya plants are observed in the nearby habitats of Huanchaco and the younger generation of fishermen have never heard of the plant. The archaeological record provides evidence of the use of cabuya in the creation of ropes and cordage since 1500 BCE, as identified in the macrobotanical record of the Gramalote site (Prieto 2015). Therefore, TEK on totora use has changed through modifications in the construction process of the caballitos favored by the availability of new construction materials in the local market as the result of globalization.

Additionally, in search for extra income, fishermen have generated new TEK of totora in that they now construct and sell souvenirs. The addition of souvenirs into their economic strategies compensates for declining fishing profits. The integration of TEK into the tourist economy is also observed in northwest Argentina where individual and community knowledge of textile craft production has adapted to new market demands (Lambaré et al. 2011). In Huanchaco, the fishing community now supplement their waning fishing profits by responding to the demand of tourists for local and innovative souvenirs that represent the Huanchaco culture. The souvenirs represent the fishing activities, which are an important part of Huanchaco identity, and provide evidence of the dynamic responses of TEK to change within subsistence-based and place-based communities, as was observed in the adaptation of TEK related to forecasting in the Hawai'ian Islands (McMillen et al. 2017).

Finally, there is some evidence of loss of totora TEK due to new construction technologies and changes in the economy of Huanchaco. Increased access to technologically advanced housing materials resulting from globalization has resulted in people replacing the use of totora mats with inorganic and more durable materials such as concrete, wood, and plastic. Also, women prefer to perform other economic activities as they perceive that mat construction does not produce a sufficient income in Huanchaco's current economy. As a result, the knowledge of mat construction and use in building will likely not persist once the sole keeper of that knowledge passes on.

In conclusion, the fishing community of Huanchaco continues to work directly with totora reeds for their subsistence activities. Totora has been used since pre-Hispanic times in the construction of the caballito de totora and the creation of mats, and more recently in the development of souvenirs. Totora TEK has economic and cultural value for Huanchaco people as the reeds generate income and represent a traditional building material emblematic of the northern region of Peru. To cope with economic and technological changes, the fishing community of Huanchaco has maintained some aspects of totora TEK while changing other aspects. Specifically, the techniques of caballito construction have persisted across generations, while some of the construction materials have changed; the use of totora in making souvenirs was developed; and a reduction in mat production has occurred. Thus, totora use in Huanchaco reflects the dynamic quality of TEK in response to social changes influenced by processes of globalization.

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CHAPTER V

CONCLUSIONS

V. 1 Plants as Important Resources for Subsistence in Coastal Communities

This ethnoarchaeological analysis of TEK on plant uses demonstrated how botanical resources contributed to the development of subsistence strategies in the coastal and fishing community of Huanchaco since prehispanic times. Although most of their living activities are related to their interaction with the sea, coastal people use plants for diverse purposes—such as food, medicinal and industrial purposes—that benefit their subsistence. An adaptation of TEK has also been identified as a response to social change. Influenced by the Spanish conquest and globalization processes, some plant uses have persisted through time, others have changed and others have become extinct. Plant TEK is part of the cultural identity of the fishing community of Huanchaco and reflects the rich diversity of cultural groups along the Peruvian territory.

Chapter I presented an introduction to this investigation on plant uses. Main concepts related to traditional ecological knowledge, paleoethnobotany and ethnoarchaeology were defined as the basis of this dissertation research. In addition, the research objectives and what was conducted to address those objectives were explained. The chapter ends with the description of the study area and the archaeological chronology of Peru.

Chapter II consisted of an ethnobotanical analysis to study the modern uses of plants of the fishing community. It showed that plants are still being used to benefit people's subsistence and that continuity of plant TEK is recognized as part of the Huanchaco's cultural identity. Medicinal plants were the most predominant and women had more knowledge on them than men. Gender and age attribute influence the intracultural distribution of plant TEK within the members of the community. Women are most knowledgeable in medicinal and industrial plants, whereas most of the population are familiar with the edible plants. In addition, taxa that were not locally available in the past are now cultivated in the Huanchaco area, and some of the prehispanic crops are no longer cultivated and consumed today. An example is observed in the today's local cultivation of *Zea mays* and the loss of TEK in the use of *Pachyrhizus* as an edible root (Paredes 2018). Also, during the colonial period, new crops were introduced into northern Peru's agriculture, such as *Medicago sativa* and *Saccharum officinarum,* reducing the availability of arable land for the cultivation of indigenous crops (Ramírez 1996). Although agricultural practices are limited in Huanchaco due to the easily accessible edible plants in the local market and the few areas suitable for cultivation, food plants are still cultivated and are part of this coastal people's diet. Their TEK on food plants has adapted to the new ecological, environmental and social conditions.

Chapter III examined the paleoethnobotanical record of Gramalote based on the modern plant use categories identified in chapter II and other the local ethnobotanical reference. The archaeological record indicated that people had access to plant resources during the Initial Period (Paredes 2018). River valley habitats facilitated the cultivation of edible plants such as *Pouteria lucuma* and *Capsicum* and industrial plants such as *Schoenoplectus californicus* and *Prosopis* used for construction purposes. In addition, the fishing village of Gramalote was part of a trading network with contemporary inland communities. They interchanged marine resources for carbohydrate-rich products including *Zea mays* and diverse species from the Solanaceae family. Most of the identified paleoethnobotanical evidence was previously recovered from earlier and later occupations in northern Peru (Bonavia et al. 2017; Gillin 1947; Ramírez 1996; Shady 2006) suggesting a continuity in the TEK of their use.

Chapter IV deepened the ethnoarchaeological approach of this dissertation by combining the resulted data in chapters II and III, and historical data from the colonial period to study the role of botanical resources in a fishing community of the north coast of Peru across time. Seven useful plants were identified in each analyzed type of record and a description of their intergenerational transmitted TEK has been presented for each one. Some uses have persisted through time, and others have partially or entirely changed as an adaptive response to processes of modernization. A case study on the use of *Schoenoplectus californicus* was presented emphasizing the dynamic quality of TEK to adapt to social change through time. People are aware of the loss of their TEK and strive to preserve it on the use of totora reeds through persistence and change from generation to generation (Paredes and Hopkins 2018). Although people have reduced their interest in continuing to use medicinal plants to treat diseases and natural products for hygiene, TEK on the use of totora reeds is still important in the indigenous identity of the fishing community of Huanchaco and, therefore, in the Peruvian culture in general.

V. 2 Botanical remains in the study of plant uses

My dissertation research highlights the importance of analyzing more than one type of botanical evidence when studying plant uses. In this investigation, micro and macrobotanical remains were analyzed, modern botanical specimens were identified, and ethnographic and historical data were consulted to understand the relationships between people and plants through time. In addition, the microbotanical analysis of inorganic evidence, and the micro and macrobotanical analysis of a great number of samples from diverse archaeological contexts may expand the number of identified useful plants dating from prehispanic times. Although the Peruvian north coast is an area with good preservation for plant remains, it is always important to consider preservation issues in the study of plant uses as some may not be recorded. As observed in the palynological record, soils with high pH (Dimbleby 1957) or high oxidation-reduction values (Tschudy 1969), the microbial activity of soil fungi and bacteria (Goldstein 1960), and cultural activities of humans (Dimbleby 1985) may cause damage to deposited pollen grains. When looking to macrobotanical remains, the useful part of a plant may not be identified and preserved because it was cooked, consumed or washed down by natural processes altering its physical properties or moving it to another archaeological context. In this investigation, the analysis of more than one type of botanical evidence, in addition to other archaeological evidence, helped to account for these issues.

V. 3 Future research

Future research will explore the cultural expansion of the use of totora reeds. In Peru, TEK on totora use has been preserved by two groups of people in two different locations. One is the fishing community of Huanchaco in the north coast and the other is the Uro people of Lake Titicaca in the south Andes. Totora use has been part of these cultures since prehispanic times, and has been influenced by drastic social changes, as observed during the colonial period (Julien 1987; Sandoval et al. 2013). This dissertation presented up-to-date research on the Huanchaco people's TEK of totora; however, the available research on the Uro people is still scarce. The ethnographic record indicates that the Uro use totora reeds for food and construction purposes. They construct houses, boats (which are bigger in comparison to the Huanchaco's), and small islands where they live (Kent 2012). The future study of the relationships between the Uro and totora will expand our understanding on how people are capable of adapting their TEK on a particular plant species in response to diverse environmental and ecological conditions. In addition, a possible ancient contact between these cultures may be traced through the study of the use of totora, suggesting processes of early diffusion and transmission of TEK among the first Peruvian inhabitants.

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APPENDIX 1

ETHNOBOTANICAL SURVEY USED IN CHAPTER II

These questions will be asked during the interview, from the beginning to the end of the survey on useful plants in Huanchaco. Through gathering this information, we will be able to identify the most important plants that the fishing community is using in their daily activities.

Do you use plants in your daily activities?

What kind of plants do you use most?

What are the names of those plant?

Where do you collect those plants?

Why you use those plants? Do they have any use?

How do you use the plant?

Which part of the plant is useful?

APPENDIX 2

DATA COLLECTION FORM USED IN CHAPTER II

The purpose of the interview is to gather the following information; it will help me to better understand how the fishermen community is using plants in their subsistence activities. I will write down all responses participants provide.

Date

Informant:

Age:

Gender:

Plant use information:

Local name:

Scientific name:

Family:

Type:

Habitat:

Use:

Parts used:

Mode of use:

Frequency:

Status:

Notes:

APPENDIX 3

BOTANICAL TAXA IDENTIFIED IN THE FOSSIL POLLEN RECORD

	Taxa	Common name		Taxa
1	*Acalypha*	Acalifa	26	Apiaceae
2	*Acacia*	Espino	27	Asteraceae
3	*Alnus*	Alder	28	Betulaceae
4	*Alternanthera*	Hierba blanca	29	Brassicaceae
5	*Ambrosia*	Artemisa	30	Bromeliaceae
6	*Capsicum*	Chili pepper	31	Cactaceae
7	*Gossypium*	Cotton	32	Amaranthaceae
8	*Monnina*	Clarin chico	33	Convolvulaceae
9	*Pachyrhizus*	Ajipa	34	Fabaceae
10	*Phaseolus*	Bean	35	Loranthaceae
11	*Physalis*	Aguaymanto	36	Malvaceae
12	*Pouteria lucuma*	Lucuma	37	Poaceae
13	*Psidium*	Guayaba	38	Podocarpaceae
14	*Prosopis*	Mesquite	39	Rosaceae
15	*Schinus molle*	Molle	40	Solanaceae
16	*Schoenoplectus*	Totora	31	Cactaceae
17	*Sonchus*	Cerraja	32	Amaranthaceae
18	*Mutisia*	Bejuco	33	Convolvulaceae
19	*Taraxacum*	Dandelion	34	Fabaceae
20	*Tillandsia*	Achupalla	35	Loranthaceae
21	*Trixis*	Lingo lingo	36	Malvaceae
22	*Typha*	Enea	37	Poaceae
23	*Urocarpidium*	Malva	38	Podocarpaceae
24	*Zea mays*	Maize	39	Rosaceae
25	Anacardiaceae		40	Solanaceae